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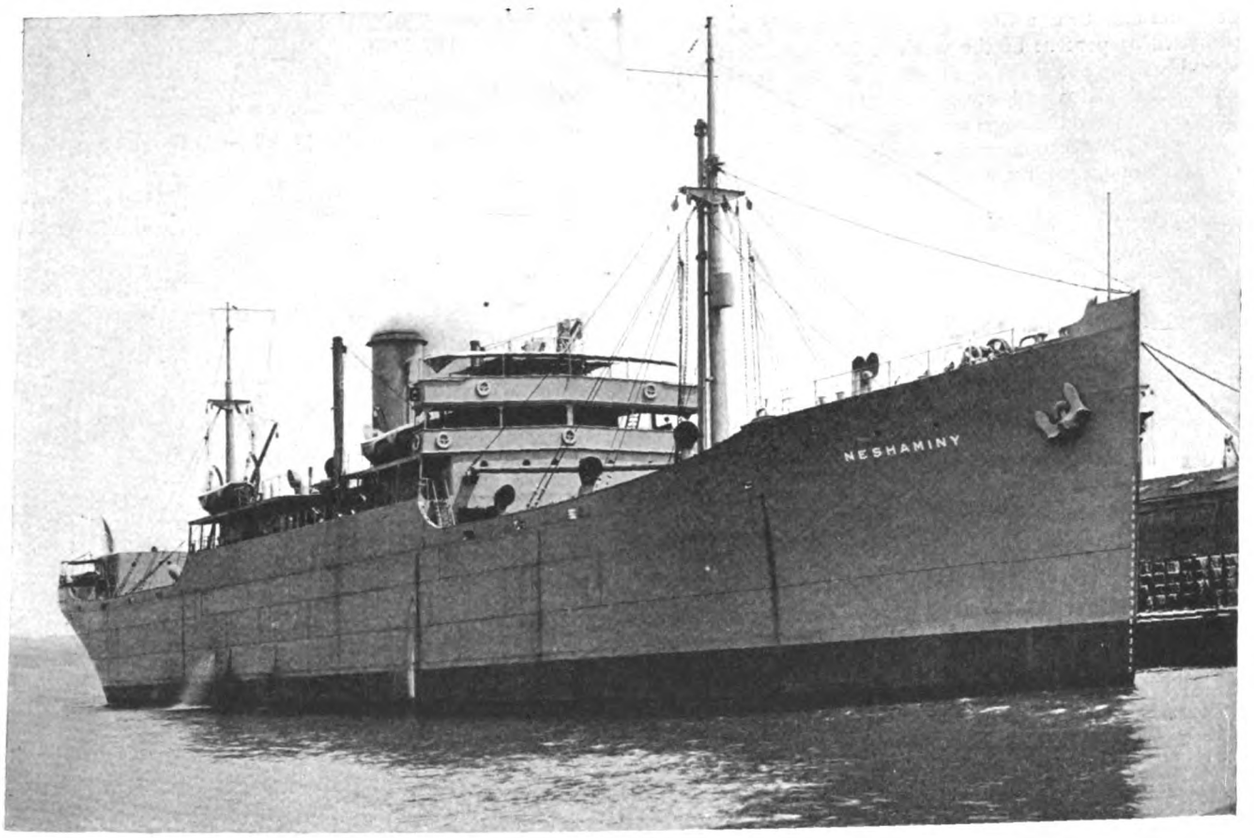

Fig. 1.—S. S. *Neshaminy*, Equipped with Westinghouse Machinery, at a Philadelphia Pier Ready to Take Her First Cargo

Westinghouse Propelling and Auxiliary Machinery Installed in Fabricated Ships

BY P. M. ROBINSON*

When the United States entered the war early in 1917 it was necessary for the Navy Department to requisition a large proportion of the capacity of the "old line" shipyards, where the expert knowledge for the building of naval craft was available, and as a result the capacity remaining for building merchant vessels, the demand for which was enormous, was comparatively negligible. To meet this great need for transport tonnage, the plan was conceived to utilize the industrial plants of the country for manufacturing the various parts of the ships and to construct shipyards where these parts could be assembled. The introduction of this idea, which had long been applied to other structural work, into the shipbuilding industry marked the beginning of the era of the "fabricated ship."

AMONG the various assembling yards which were built during the war for the construction of "fabricated" ships is the one located at Bristol, Pa., on the Delaware river, known as the Merchant Shipbuilding Corporation. The site for the yard was purchased by the Harriman interests, who became agents of the United States Shipping Board Emergency Fleet Corporation, and work was started in September, 1917, although the actual contract was not signed until October, 1917. Already located on the site were a few buildings taken over from the Standard Cast Iron Pipe and Foundry Company, but the remainder of the property consisted of open fields and meadows.

Eleven months from the time that work was started the

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first vessel was launched, and at the end of two years fourteen completed ships had been turned over to the operating division of the Shipping Board.

METHOD OF FABRICATION

Practically all of the steel work in the vessels built by the Merchant Shipbuilding Corporation is fabricated by the American Bridge Company, and as nearly as can be estimated 83 percent of the work is fabricated ready fo assembly before it reaches the yard. Keels, frames, bulkheads, shell plates and super-structures are all cut, bent, punched and riveted together in as large units as can be transported and economically handled.

The main propelling units, together with the principal engine room auxiliaries, are supplied by the Westinghouse Electric & Manufacturing Company. The boilers are furnished by the Babcock and Wilcox Company.

Inasmuch as such a large part of the work is completed when the various parts reach the yard, the equipment required in a fabricated shipyard is very much simpler than that usually found in a shipbuilding plant, consisting of the following:

(1) Launching ways, with the necessary crane facilities and other adjuncts.
(2) Fitting-out docks, with the necessary cranes and transportation facilities.
(3) Storehouses and storage yards for the storage of the untold number of parts.
(4) A few small shops for doing miscellaneous work in connection with the completion of the ships.
(5) Sufficient fabricating capacity to complete the ships, rectify errors, etc.

In the Merchant Shipbuilding Corporation yard there are twelve launching ways, and it is estimated that one complete boat can be turned out every fifteen or twenty days, although this schedule has not yet been attained. The present deliveries are at the rate of approximately eighteen ships per year.

GENERAL DESCRIPTION OF THE VESSELS

The vessels built by the Merchant Shipbuilding Corporation are single-screw cargo boats of about 9,000 tons capacity, the general dimensions of which are as follows:

Length overall	417 feet 8 inches
Length between perpendiculars	401 feet 0 inches
Beam, molded	54 feet 0 inches
Depth, molded	32 feet 10 inches
Designed draft, light	7 feet 8 inches
Designed draft, loaded	25 feet 2 inches
Block coefficient	.79
Displacement, light	3,403 tons
Displacement, loaded	12,225 tons
Deadweight carrying capacity	8,822 tons
Designed speed	11 knots
Cubic capacity (including hold No. 3, 'tween deck side bunker and bridge bunker)	476,205 cubic feet
Fuel oil capacity (38 cubic feet per ton)	1,140 tons
Fresh water capacity, potable	25.7 tons
Fresh water capacity, reserve feed	137 tons
Designed shaft horsepower	3,000
Estimated steaming radius	7,400 miles

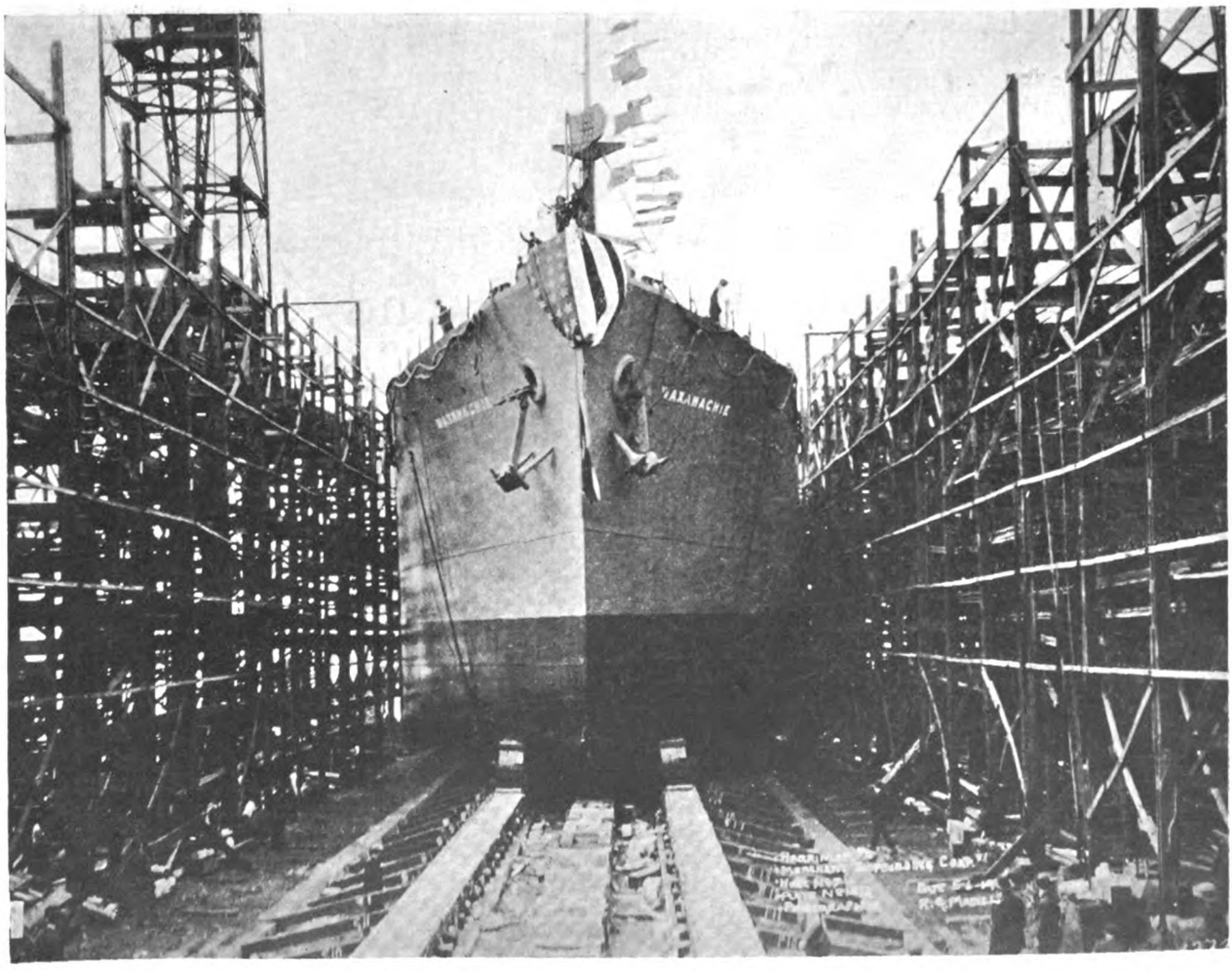

Fig. 2.—Launching of One of the Fabricated Ships at the Harriman, Pa., Yard of the Merchant Shipbuilding Corporation

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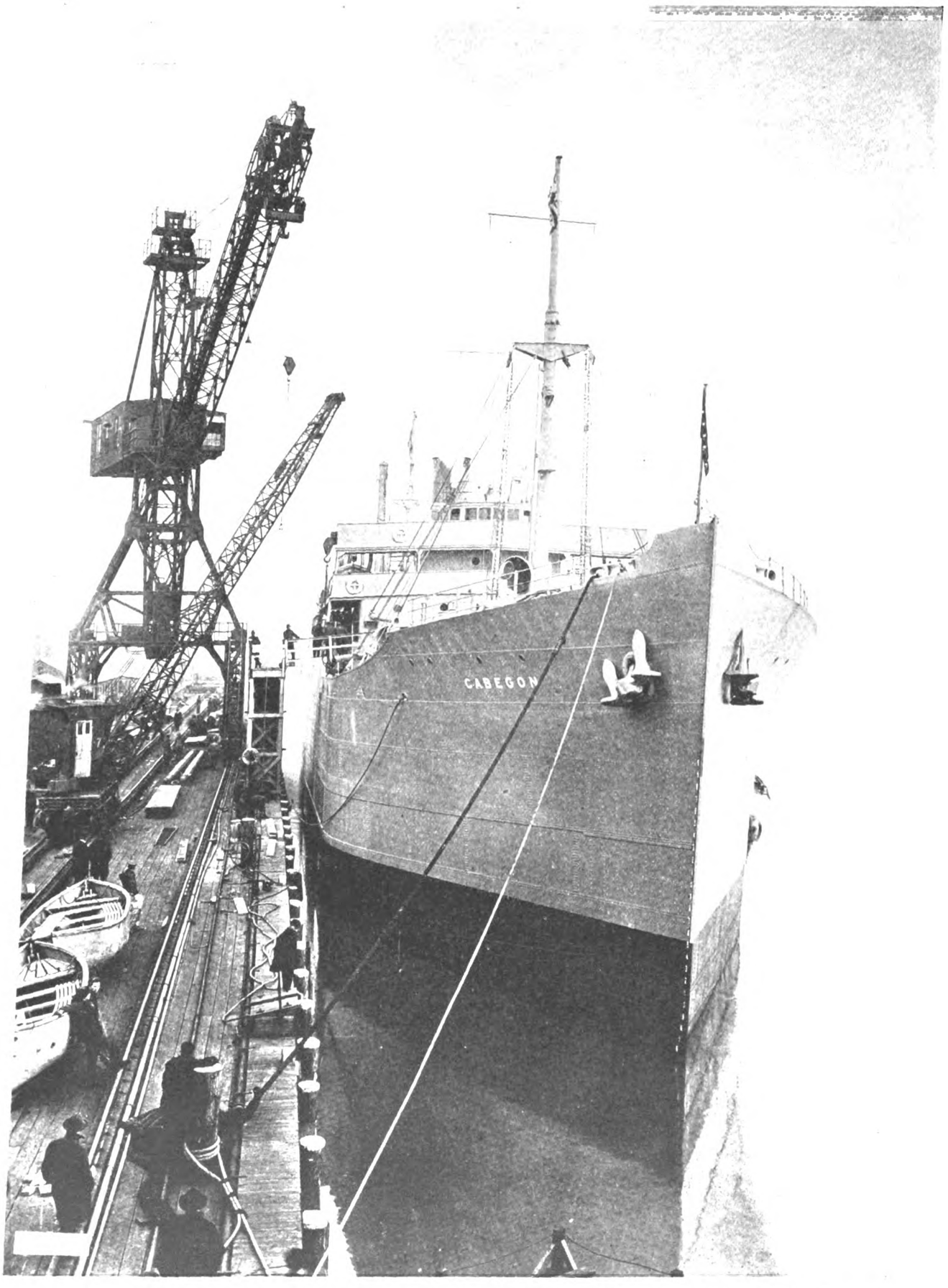

Fig. 3.—Fabricated Ship at Fitting-Out Dock of Merchant Shipbuilding Corporation Receiving Complete Westinghouse Machinery Equipment

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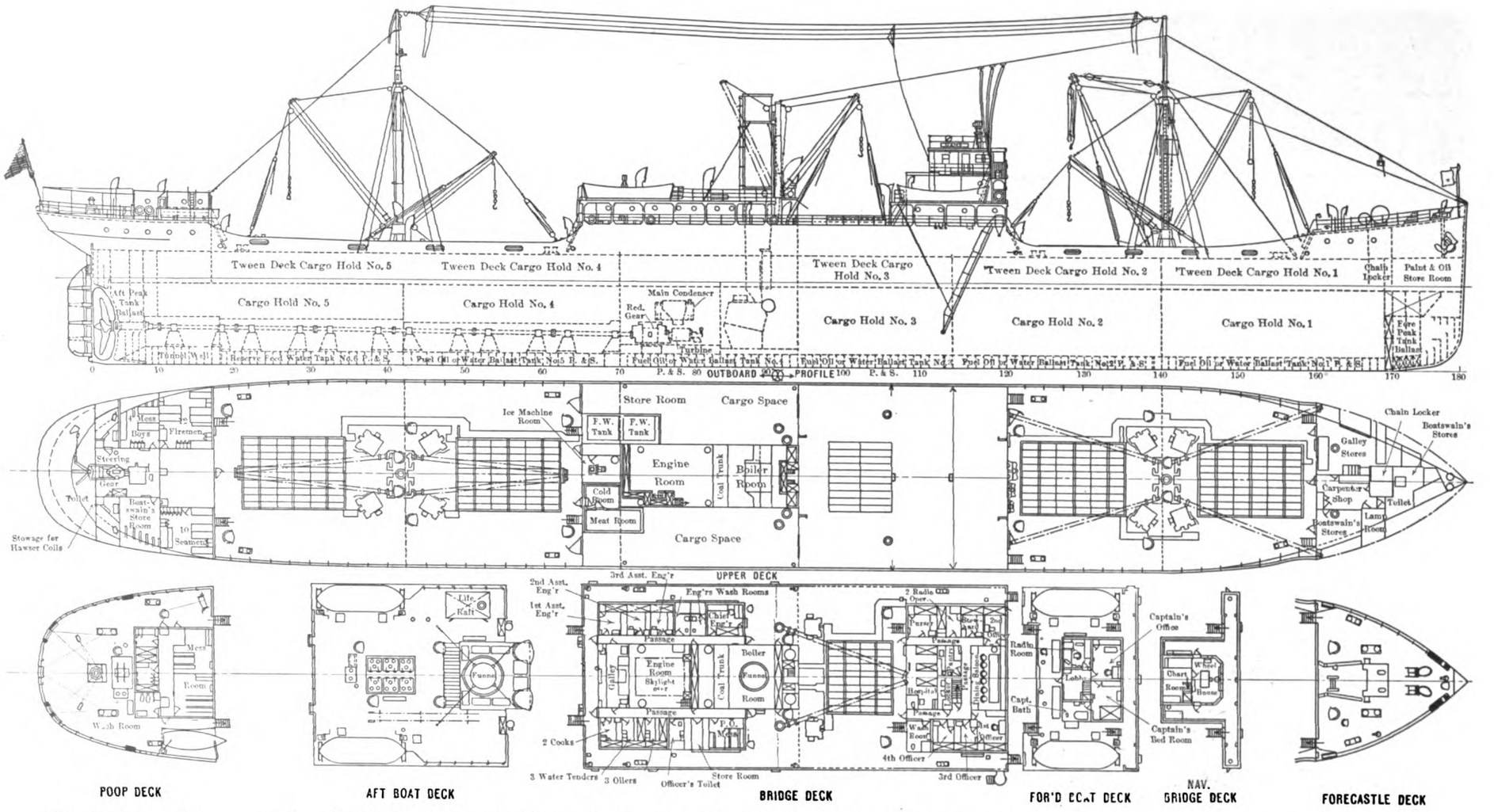

Fig. 4.—General Arrangement Plans of 9,000-Ton Deadweight Fabricated Cargo Vessel Built by the Merchant Shipbuilding Corporation, Harriman, Pa., and Equipped with Westinghouse Propelling and Auxiliary Machinery

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These vessels are built under the joint rules and inspection of Lloyd's Register of Shipping and the American Bureau of Shipping and are of the highest classification.

With many years of experience in the building of power equipment, both stationary and marine, the Westinghouse Electric & Manufacturing Company was well able to assume the work of furnishing the complete propelling equipment, which consists of the following units:

Main turbines	3,000 shaft horsepower
Reduction gears	3,360-90 revolutions per minute
Main condenser	4,000 square feet
Auxiliary condenser	800 square feet
Main circulating pump unit	4,000 gallons per minute
Two condensate pump units	6,000 gallons per hour each
Two air ejectors	Size "E"

The Westinghouse Company is also furnishing the complete line shafting, together with the line shaft bearings and sterntube.

The boiler equipment consists of three Babcock and Wilcox watertube boilers of 2,900 square feet of heating surface each, fired with oil, using Schutte and Koerting burners. There is also included a Foster superheater in each boiler with a heating surface of 290 square feet and an induced draft system using a Sturtevant fan.

In addition to the main units there are the following pumps and miscellaneous auxiliaries:

Two boiler feed pumps, National Transit, 12 inches by 8 inches by 24 inches, vertical simplex.
One bilge pump, National Transit, 6 inches by 5¾ inches by 6 inches, vertical duplex.
One fire and bilge pump, National Transit, 10 inches by 8½ inches by 12 inches, vertical duplex.
One ballast pump, National Transit, 10 inches by 12 inches by 12 inches, horizontal duplex.
One fresh water pump, Worthington, 4½ inches by 3¾ inches by 4 inches, horizontal duplex.
One sanitary pump, Worthington, 6 inches by 5¾ inches by 6 inches, horizontal duplex.
Two lubricating oil pumps, Worthington, 7½ inches by 7 inches by 10 inches, vertical duplex.
One lubricating oil cooling water pump, Worthington, 7½ inches by 7 inches by 10 inches, vertical duplex.
Two fuel oil pumps, National Transit, 5¼ inches by 3½ inches by 5 inches, horizontal duplex.
One fuel oil transfer pump, National Transit, 7½ inches by 7½ inches by 10 inches, horizontal duplex.
One evaporator pump, National Transit, 4½ inches by 4 inches by 4 inches, horizontal duplex.
Two 15-kilowatt General Electric generators with reciprocating engines, 8 inches by 6 inches, vertical.
One combined auxiliary air and circulating pump, Dean.
Two Griscom-Russell oil coolers, 300 square feet.
One Schutte and Koerting duplex oil strainer, 4-inch.
One Richardson Phœnix oil filter, No. 75.
One Frick refrigerating machine, 1 ton.
One evaporator, Locomotive Feed Water Heater Company.
One Griscom-Russell distiller.
One feed heater, Locomotive Feed Water Heater Company.

The propeller is four-bladed, cast iron, turning at 90 revolutions per minute, having a diameter of 17 feet, a pitch of 14 feet and a developed area of 90.33 square feet.

The deck machinery and other miscellaneous equipment consists of the following:

One windlass, Welin Marine Equipment Company, 10 inches by 10 inches.
One capstan, Hyde Windlass Company, 8 inches by 8 inches.
Eight winches, American Clay Machinery Company, 9 inches by 9 inches.
Two winches, Lidgerwood, 8¼ inches by 8 inches.
Steering gear, Williamson screw type, American Engineering Company, 9 inches by 9 inches.
Wireless, Lowenstein navy type, 2-kilowatt.
Searchlight, Carlisle & Finch, 8,000 candle-power, 18-inch.

The propelling machinery furnished by the Westinghouse Electric & Manufacturing Company represents the latest development in marine geared turbine equipment, and a description of the various units is as follows:

The turbines are of the Westinghouse combined impulse-reaction, cross-compound type, consisting of a high-pressure and a low-pressure unit, each of which is connected to a first reduction pinion through a flexible shaft and coupling.

Main Turbines

The high-pressure turbine consists of a two-row impulse stage followed by a reaction drum from which the steam exhausts through a cross-connecting pipe into the low-pressure turbine, where the expansion is completed in a second drum of reaction blading. By an arrangement of emergency pipes and valves it is possible to operate either turbine alone under high-pressure steam, exhausting directly into the condenser.

The reversing requirements are taken care of by placing a two-row impulse stage in the exhaust end of each unit, which are compounded in a similar manner to the ahead elements. High-pressure steam is admitted to the astern element of the high-pressure turbine only, from which it exhausts through a cross-connecting pipe into the astern element of the low-pressure turbine.

The astern turbines are capable of developing 60 percent of the full load power ahead when supplied with a steam flow equal to the full power ahead condition.

By an arrangement of emergency pipes and valves similar to that for ahead operation it is possible to operate either the high-pressure or the low-pressure astern element independently, using high-pressure steam and exhausting directly into the condenser.

Full Power Operating Condition

Steam pressure at turbine inlet	185 pounds per square inch gage
Superheat	50 degrees F.
Speed	3,360 revolutions per minute
Normal power	3,000 shaft horsepower
Water rate, exclusive of auxiliaries	11.25 pounds per shaft horsepower per hour
Vacuum, referred to 30-inch barometer	28 inches Hg.
Reversing power	1,800 shaft horsepower

The ahead inlet nozzles are arranged in three groups. The main group contains sufficient area to pass 85 percent of the full load steam flow and two auxiliary groups contain 20 percent of normal steam flow area each. These last two groups can be opened or closed by means of hand valves, and under normal conditions full power will be obtained with one hand valve open, there being a slight margin allowed, so that the inlet pressure need not be kept at the maximum all the time. By opening the second hand valve the steam flow may be increased to the extent of 25 percent above that normally required for full load, thus permitting full power to be realized at any time should the pressure, vacuum or both fall a corresponding amount below normal operating conditions.

The astern nozzles are not arranged for group control because economy when operating astern is of little importance.

The turbine cylinders are made of close-grained cast iron and consist of base and cover joined by horizontal flanges. The stationary reaction blading is mounted in grooves on the inside of the cylinders.

The high-pressure inlet nozzles—both ahead and astern—are of the diverging type, made of cast bronze, hand-finished and are mounted in the steel nozzle chambers, which bolt onto the inside of the cylinders. These nozzle chambers also form the base on which the stationary impulse blades are mounted, thus insuring perfect alinement between the nozzles and the stationary blades at all times.

At the exhaust end of each turbine the main bearing

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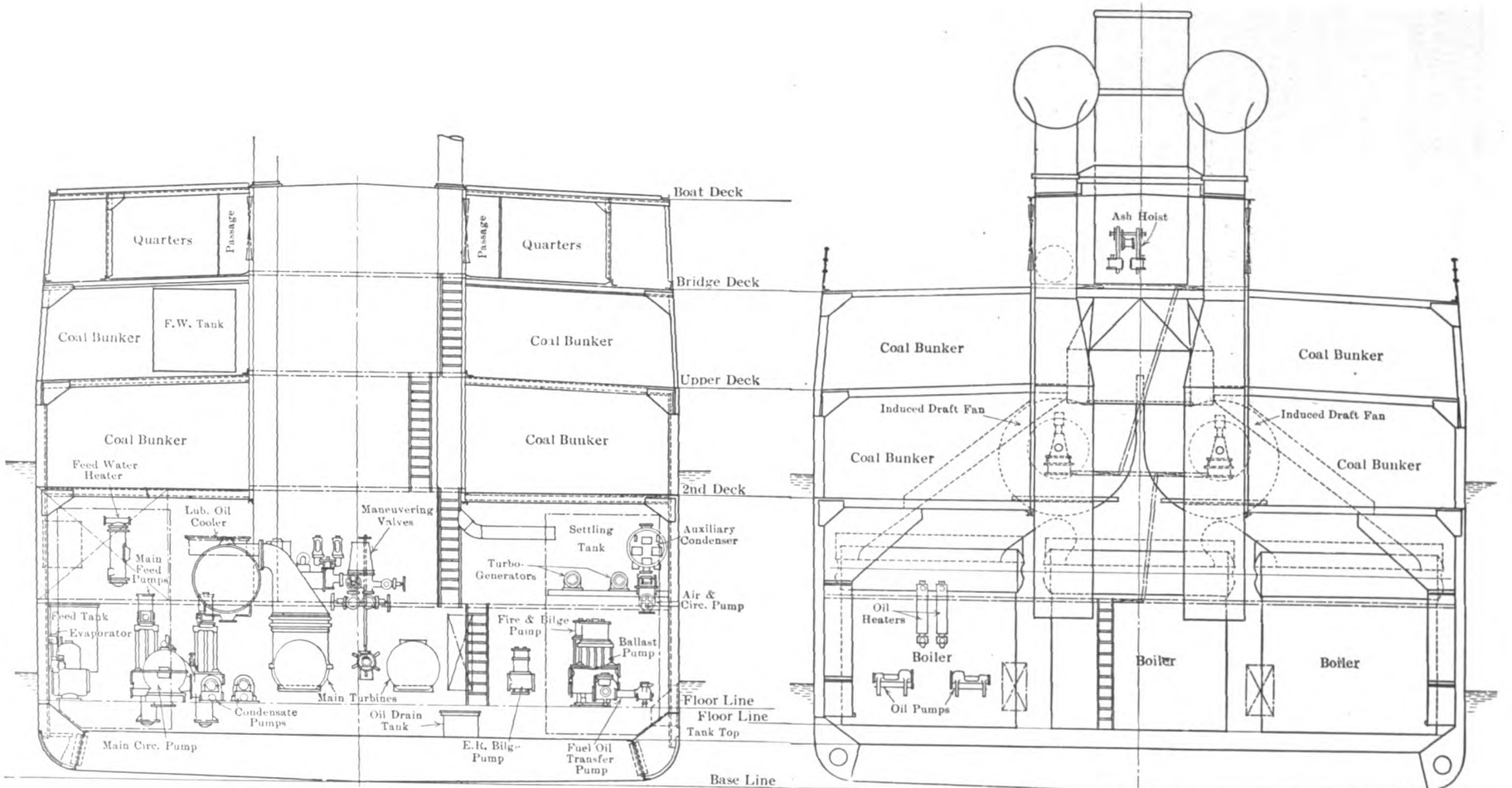

Section at Frame No. 74, Looking Forward

Section at Frame No. 93, Looking Aft

Fig. 5.—Sections Through Engine and Boiler Rooms

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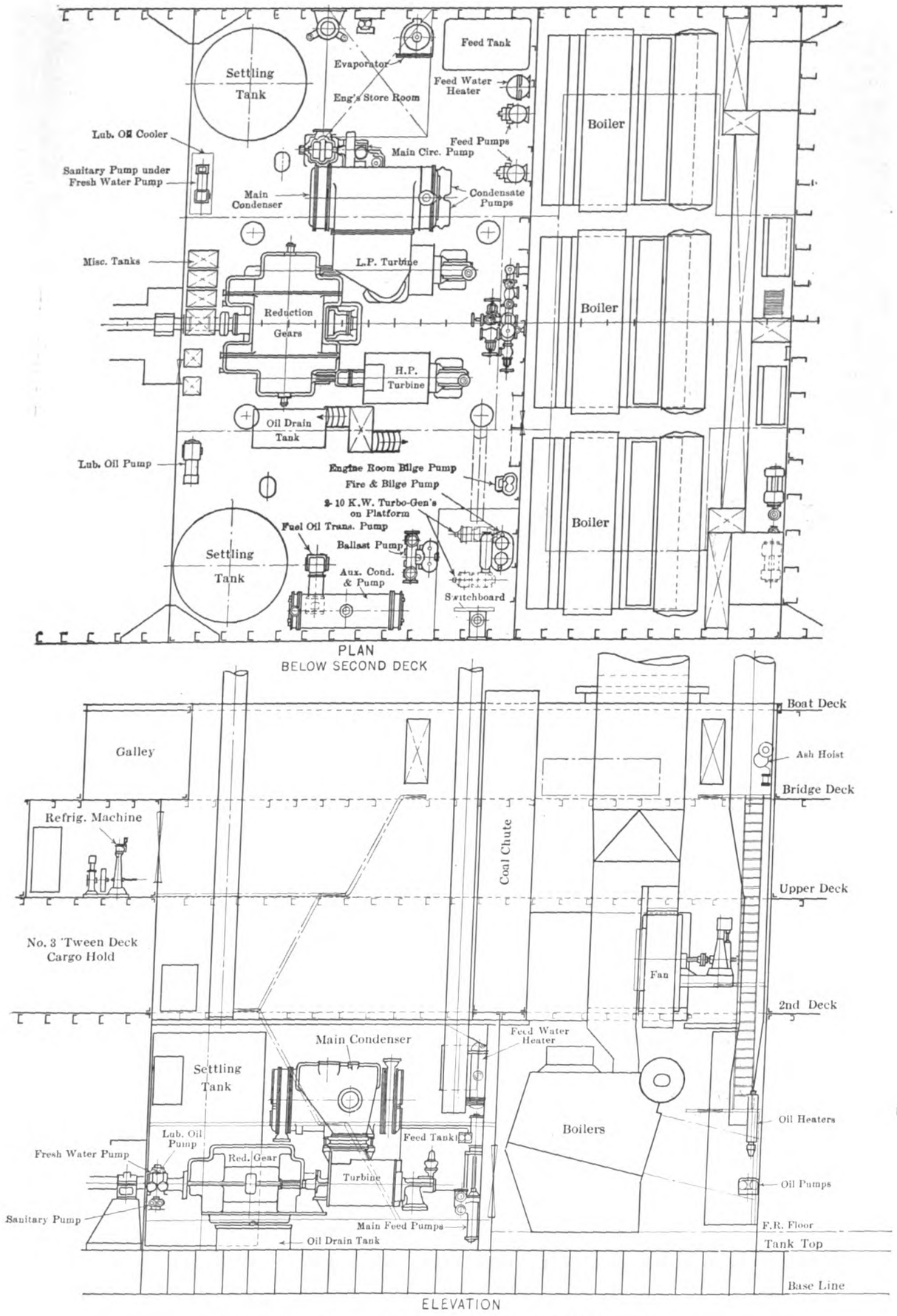

Fig. 6.—Plan and Longitudinal Section Through Machinery Space

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pedestal is cast as an integral part of the base, while at the inlet end the pedestal is a separate casting bolted on. This forward pedestal carries not only the main bearing, but also the thrust bearing and the governor.

The after bearing pedestal is rigidly bolted down to the seating (several of the bolts being fitted), but the forward pedestal is provided with a sliding foot supported by a steel sole plate with guides, which permit of horizontal longitudinal movement only. Thus, the turbines are free to expand or contract endwise without setting up any stresses tending to warp the cylinders.

The main bearings are of the self-alining type consisting of cast iron shells in halves, lined with genuine babbitt metal and provided with pads and adjusting liners on the top, bottom and sides. Oil is fed to the bearings under pressure, being admitted through a passage drilled in the bottom pad and liners, and conveyed to the top of the bearing by means of a tube which is cast in the babbitt lining. The bearing housings and covers are fitted with oil guard rings, which prevent any leakage of oil along the shaft and at the same time exclude dust.

The turbine rotors are of the hollow drum construction, being made of a high grade of open hearth steel. The high-pressure turbine rotor is built up of two parts securely bolted together, while the low-pressure turbine rotor consists of three parts. However, in both cases the impulse wheels are included as integral parts of the rotor elements.

By this drum type of construction a very rigid spindle is obtained in which the deflections are so small that the first critical speed is far above the normal running condition.

The impulse blades are very rugged in construction, being machined out of nickel steel sections and secured in the rotor by a tongue and groove construction with side wedges to prevent vibration. The shrouding is formed as an integral part of the blades and additional stiffness is obtained by a circumferential binding strip which is driven into a dovetail groove and brazed.

The reaction blades are made of phosphor bronze and are secured in the dovetail grooves by a positive mechanical interlock between the blades, the packing pieces and the sides of the groove.

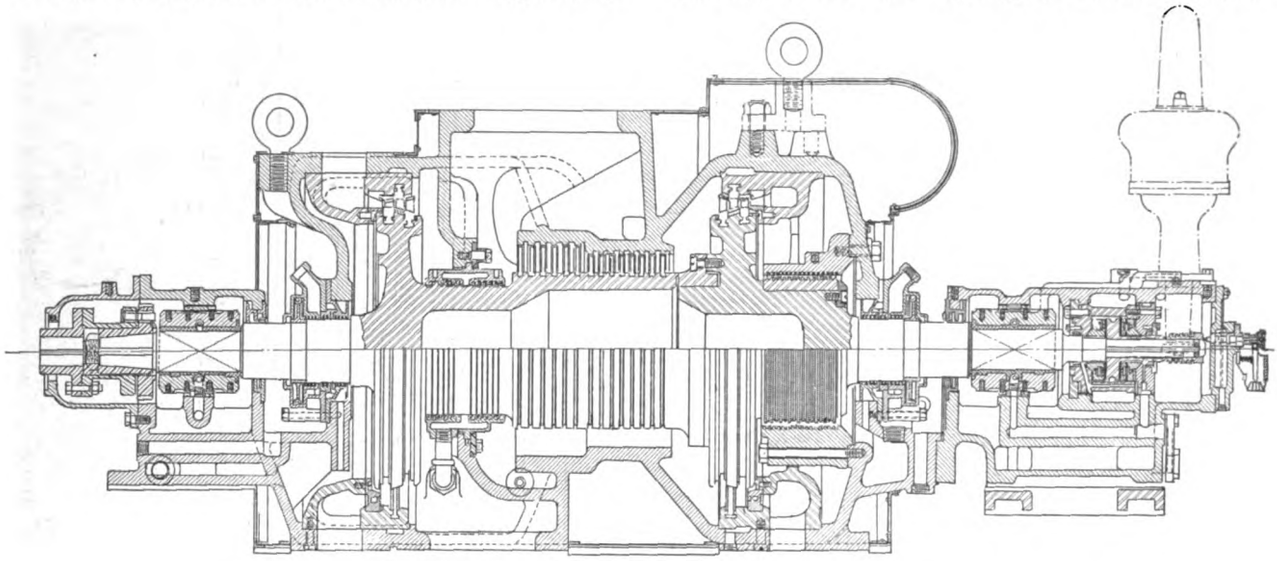

Fig. 7.—Longitudinal Section Through High-Pressure Turbine

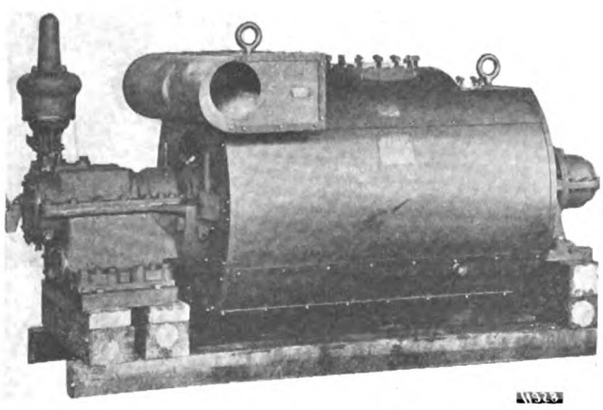

Fig. 8.—High-Pressure Turbine

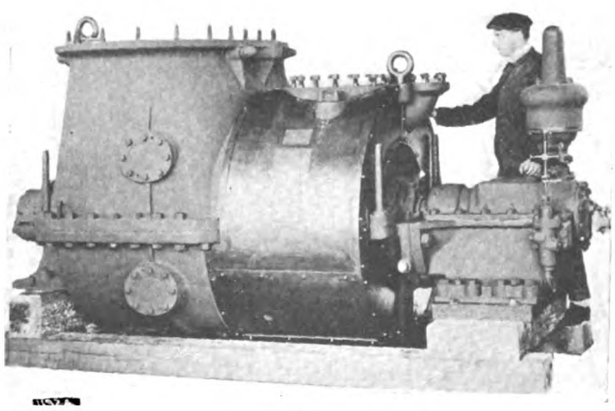

Fig. 9.—Low-Pressure Turbine

In the bottom of the main groove there is cut a supplementary groove into which extends an upset foot on the blade. This upsetting operation increases the thickness of the whole lower portion of the blades, adding to their area about 40 percent, tapering off to the standard section some distance above the surface of the blade-carrying element. This thickening is not clearly shown in Fig. 18. Dovetail packing pieces are inserted between the blades, and the forged foot of each blade coming beneath the

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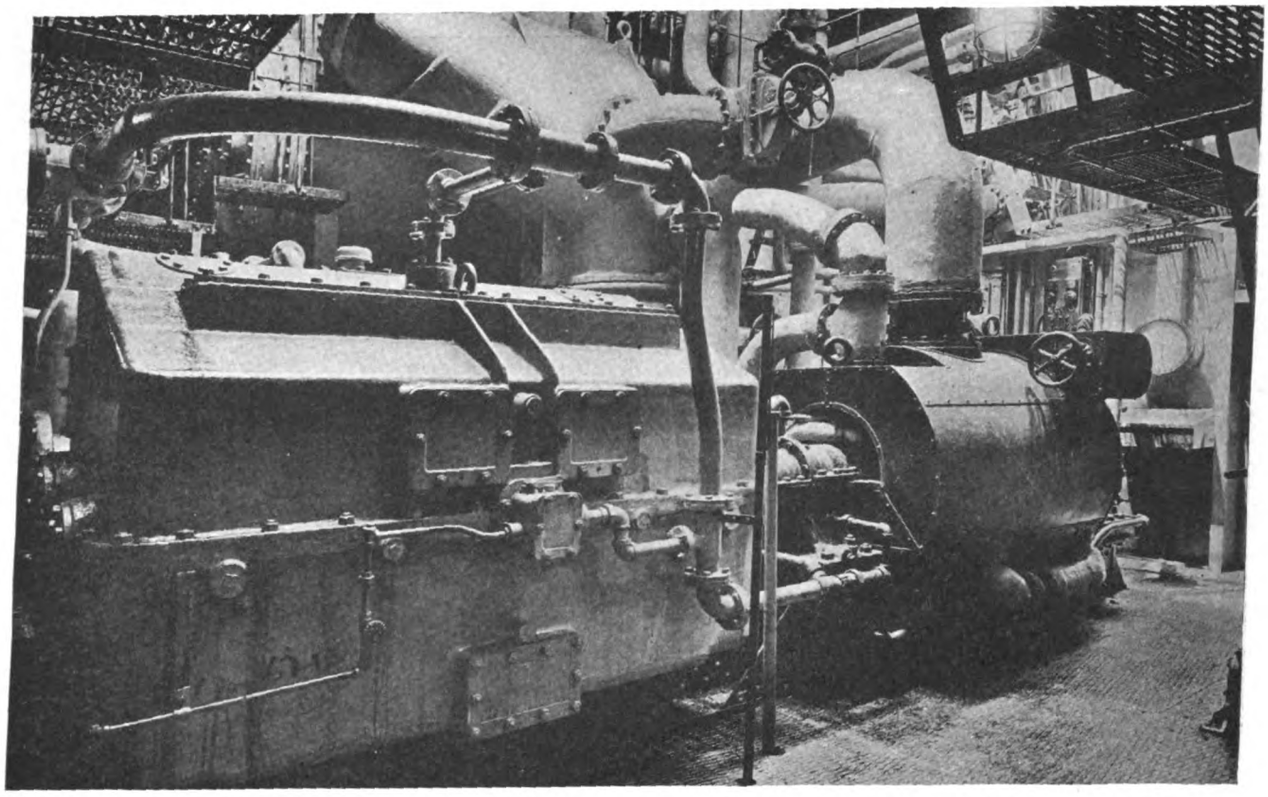

Fig. 10.—View of Engine Room Looking Forward from Starboard Side, Showing Reduction Gear and High-Pressure Turbine

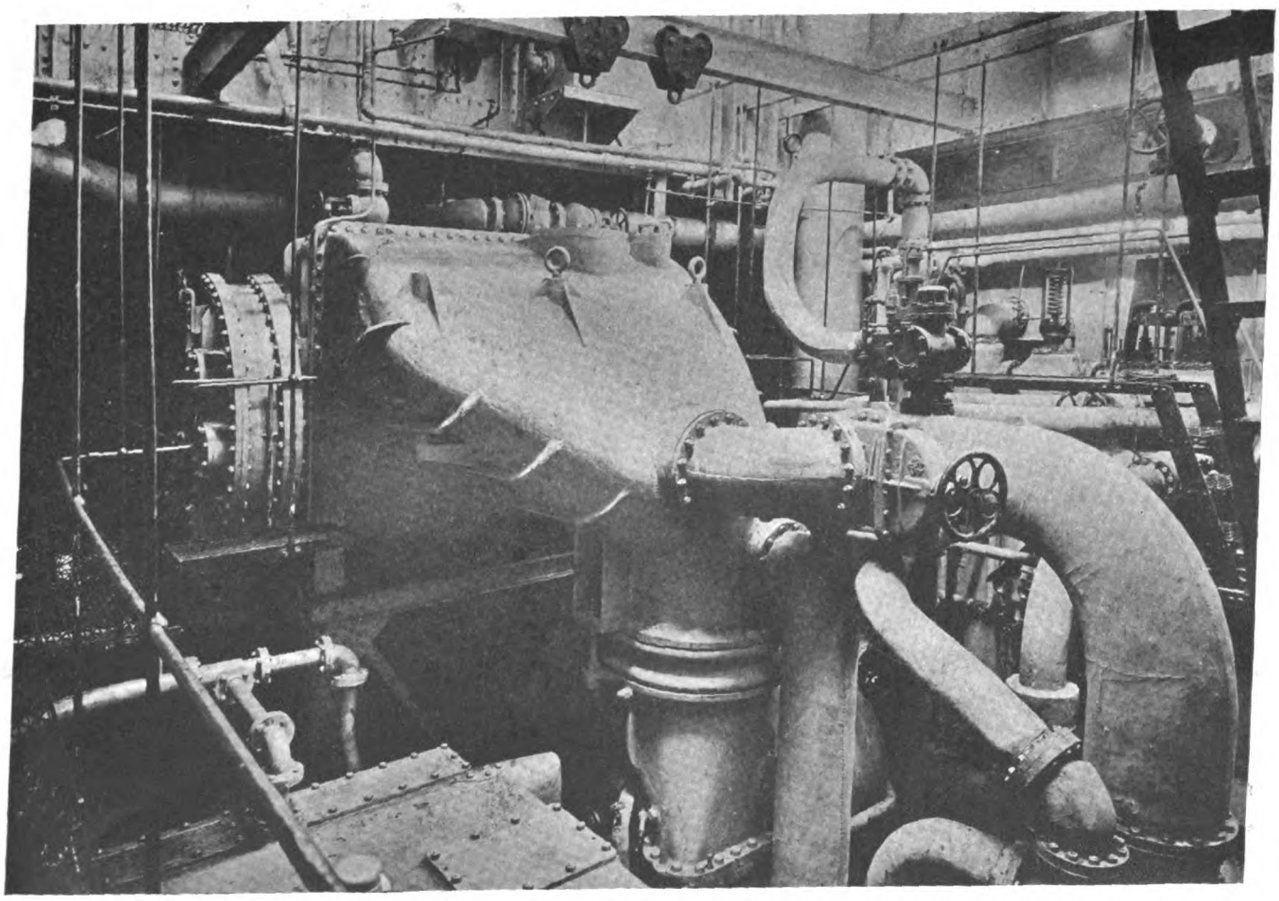

Fig. 11.—View of Engine Room from Lower Grating, Showing Low-Pressure Turbine, Main Condenser and Exhaust Trunk

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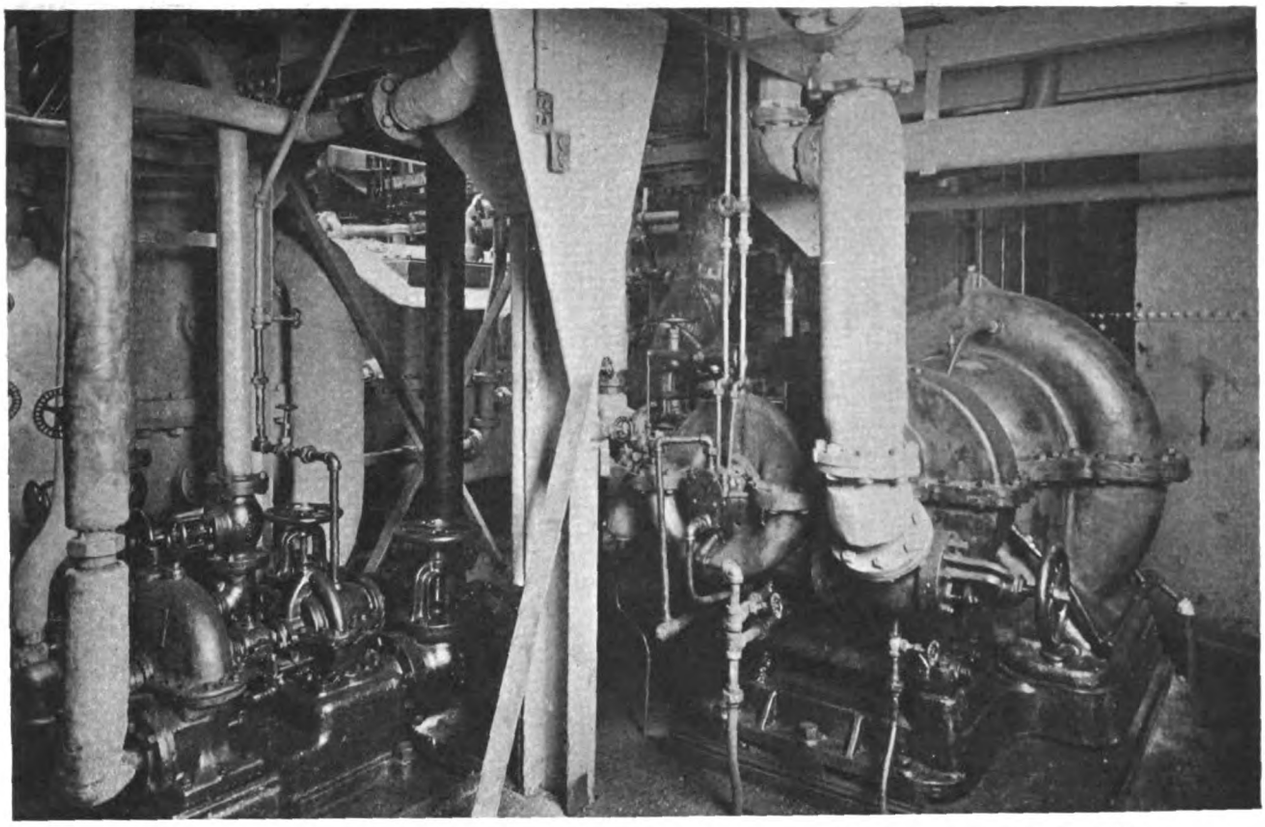

Fig. 12.—View of Engine Room from Port Side Looking Aft, Showing Condensate Pumps and Main Circulating Unit

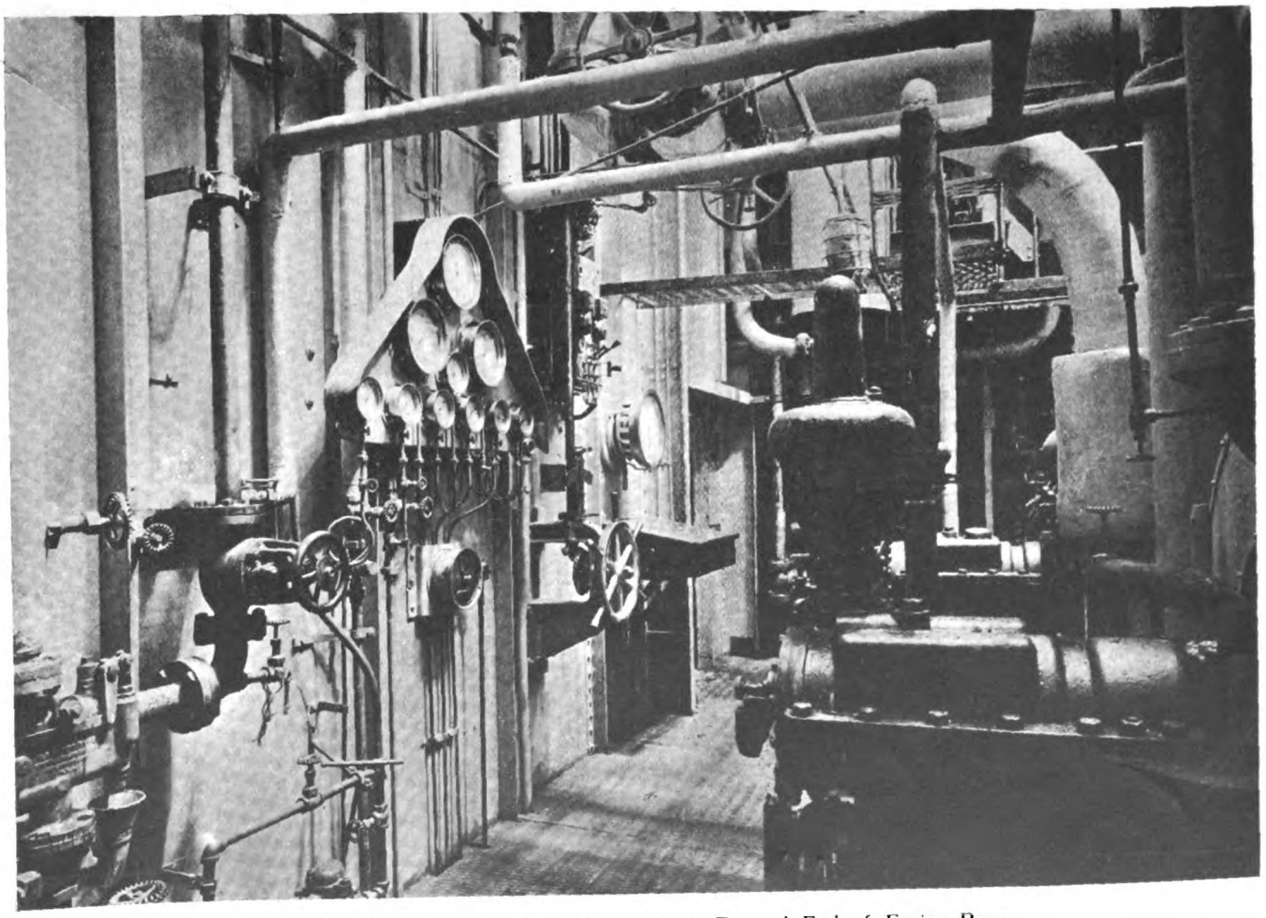

Fig. 13.—View Showing Operating Platform at Forward End of Engine Room

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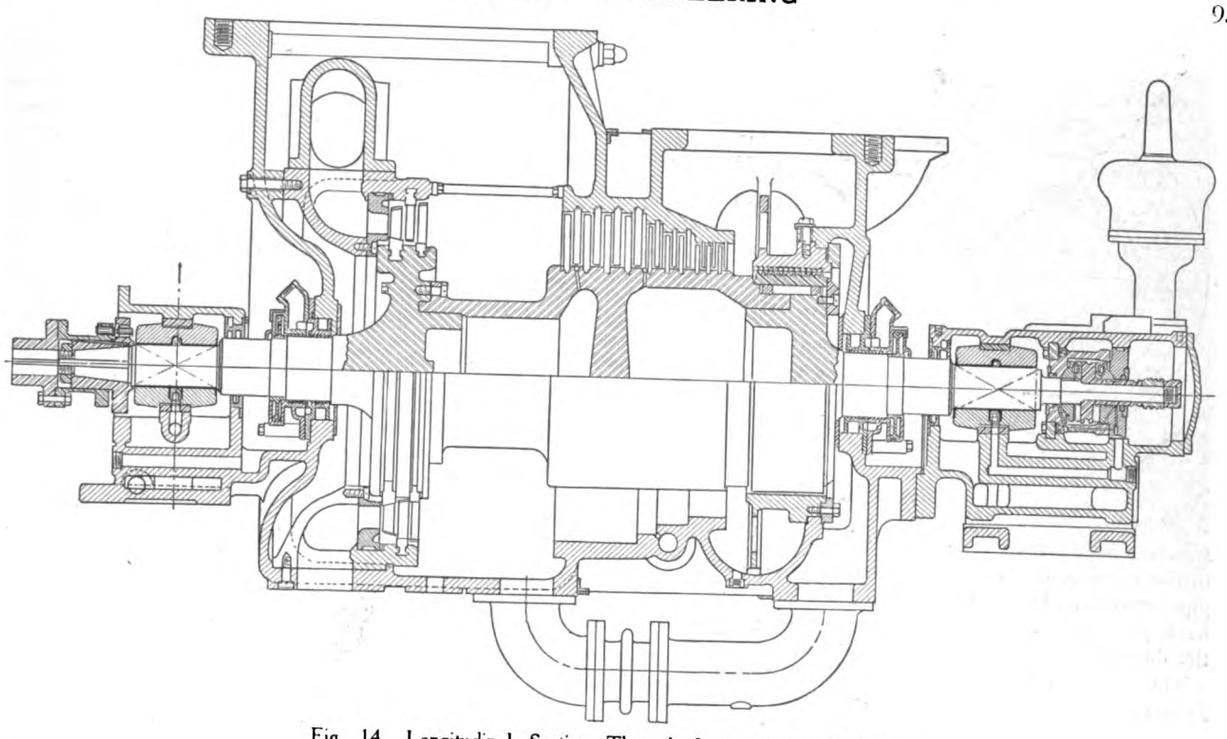

Fig. 14.—Longitudinal Section Through Low-Pressure Turbine

packing pieces provides an interlocking system with which no calking is necessary, making it possible to replace blades an indefinite number of times without mutilation of the blade-carrying member.

Lashing wires in sufficient number are provided for bracing the upper ends of the blades, the number of these lashings depending on the length of the blades.

As in all turbines of this type, when in operation there is an axial thrust due to the steam pressure, tending to move the spindle endwise. This is partly counterbalanced by means of a balance piston or dummy of the radial contact type placed at the forward end of each turbine and the remainder of the end thrust is absorbed by a Kingsbury type thrust bearing. By this arrangement a short dummy of small diameter is obtained, which feature adds considerably to the reliability and prolonged economy of the machine. The dummy piston is formed by a forged steel ring shrunk and keyed to the turbine spindle. On this ring are turned square ridges alternately high and low. In the cylinder dummy ring, which is a casting bolted to the cylinder, are fitted narrow aluminum strips which are turned to correspond with the ridges on the dummy piston. The inner edges of the aluminum strips are approximately 1/32-inch wide and clear the ridges on the dummy piston by only a few thousandths of an inch, thereby reducing the steam leakage to a very small amount. However, since the close clearance is in a radial direction only, the dummy imposes no limits on the end movement of the

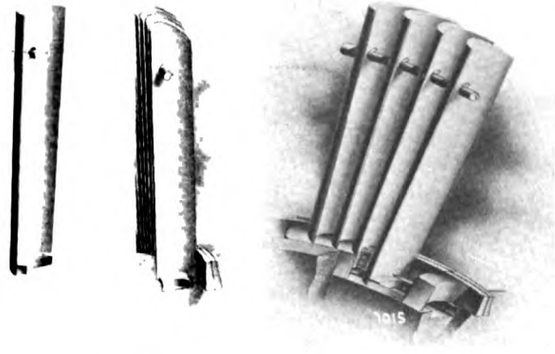

Fig. 15.—Reaction Blade Construction

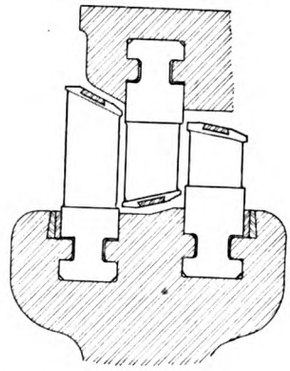

Fig. 16.—Impulse Blade Construction

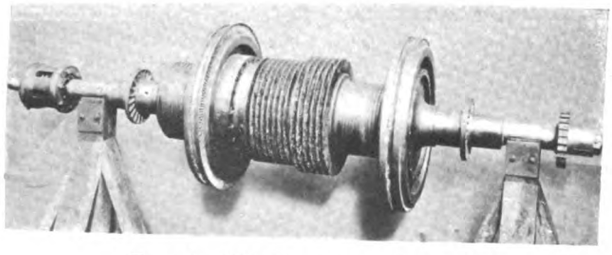

Fig. 17.—High-Pressure Turbine Rotor

Fig. 18.—Low-Pressure Turbine Rotor

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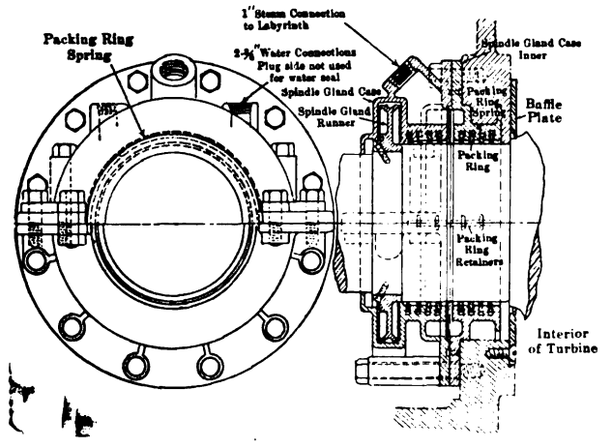

Fig. 19.—Spindle Gland

spindle. Whatever steam leaks past this packing is carried to the exhaust end of the turbine through a liberal-sized pipe known as the equilibrium pipe, thus preventing any back pressure from building up on the outside end of the dummy.

The glands for preventing leakage where the spindle passes through the casing at each end are of the combined steam and water sealed type. The water gland is designed effectively to seal at all speeds from and above half speed, and below that the steam seal is used.

The water gland consists of a runner similar to the runner of a centrifugal pump which revolves in the gland casing. Fresh water is supplied from the condensate gravity tank and a solid annulus of water is maintained at the outer edge of the runner, thereby producing an hermetic seal which entirely precludes leakage.

The steam seals on the low-pressure turbine consist of two sets of aluminum packing rings with an opening between, to which steam is admitted at a reduced pressure. On the high-pressure turbine the steam seals are somewhat different, because they have to pack against a pressure greater than atmosphere. In this case there are three sets of packing strips. Between the two inner sets is a leak-off chamber, which is piped to a suitable connection on the low-pressure turbine, serving to dispose of the leakage steam, and at the same time utilize it to good advantage in the low-pressure blading. Reduced pressure sealing steam is supplied to the opening between the two outer sets of rings the same as in the low-pressure glands.

The steam and water used for sealing the turbine glands may be controlled by hand-operated valves or by the gland control valve which automatically regulates whether the steam or the water shall be in use according to the speed of the turbine. This is accomplished by incorporating in the governor relay valve an extra set of ports which operate the gland control valve in a similar manner that the main ports operate the main governor valve. The governor is provided with two springs and its travel is divided into two zones. The inner travel of the governor weights is opposed by the light spring only, the governor weights being able to compress this spring at the speed at which the gland should change over from the steam seal to water seal. The heavy spring comes into engagement at this speed, but the governor weights are unable to compress the two springs together until the turbine reaches the speed corresponding to which the governor should regulate the steam supply to the turbine (approximately 8 to 10 percent overspeed).

Motion of the governor through the first part of its travel will, by means of the relay which it operates, either relieve or impose pressure in the chamber "x" of the gland

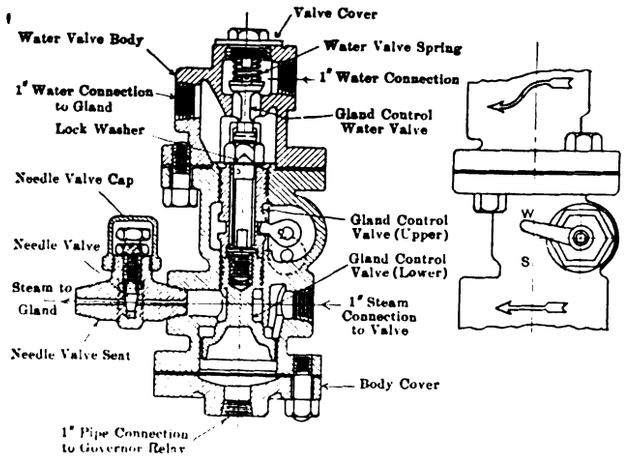

Fig. 21.—Automatic Gland Control Valve

control valve, causing motion of the valve to either change from steam to water or vice versa, according to whether the turbine speed is accelerating or retarding.

These spindle glands can be removed for inspection or repair without disturbing the turbine casing.

To separate the ahead and astern chambers of the high-pressure turbine, which are always at different pressures, there is interposed a diaphragm cast as an integral part of the casing. The packing between the diaphragm and the rotor is of the labyrinth type, very similar to the steam glands at each end of the turbine, with the exception that between each two packing strips a slight ridge is turned on the rotor which further impedes the flow of the steam tending to leak through. The packing is divided into two groups of strips with an annular space between, from which a pipe leads to a suitable stage in the low-pressure turbine. Any leak past the first set of labyrinth rings is thus taken care of and utilized to advantage in the low-pressure blading.

The Kingsbury thrust

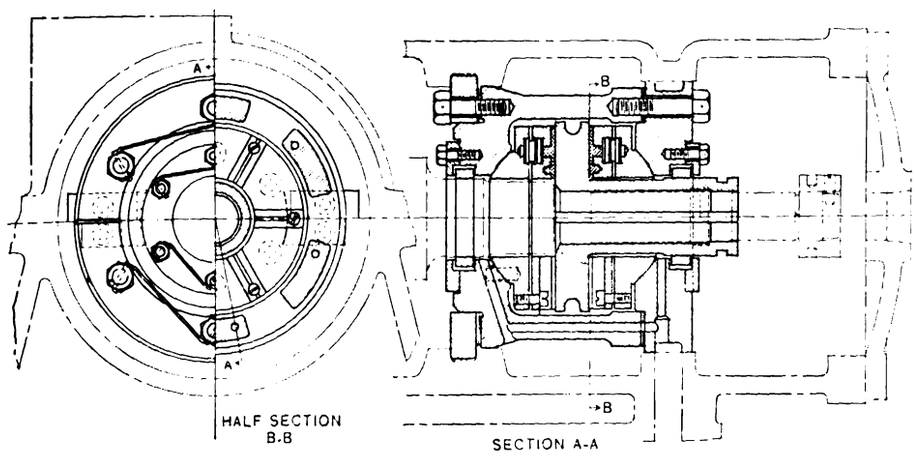

Fig. 20.—Turbine Thrust Bearing

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bearing mounted on the forward end of each turbine consists of steel collar keyed to the shaft with a set of segment-shaped shoes on each side to take the thrust in either ahead or astern direction. The shoes are faced with genuine babbitt metal, and in the back of each is fitted a spherically-faced hardened steel button. These buttons

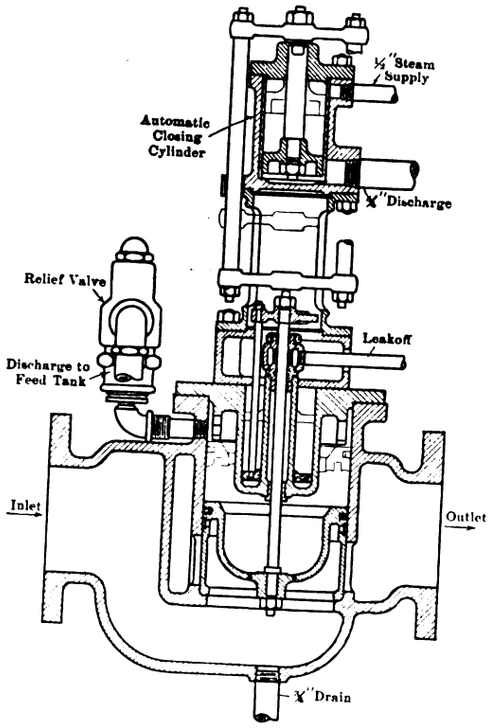

Fig. 22.—Constant Pressure Valve

rest on flat, hardened steel pieces inserted in a spherically-seated base ring, which automatically centers itself, so as to distribute the load equally over all the thrust shoes.

The base rings are supported in an inner skeleton housing which is held from moving endwise by a steel adjusting ring which fits into a groove in the outer housing. Adjustment of the longitudinal blade clearances is made by moving the inner thrust housing as a whole one way or the other, which is effected by changing the total thickness of the liners between the inner housing and the adjusting ring.

The thrust bearing is lubricated by oil passing through drilled passages into the periphery of the shaft on each side of the collar, and, in order to keep the entire housing filled with oil at all times, the inlet is placed at the bottom and the outlet on top, the outgoing oil passing to the gov-

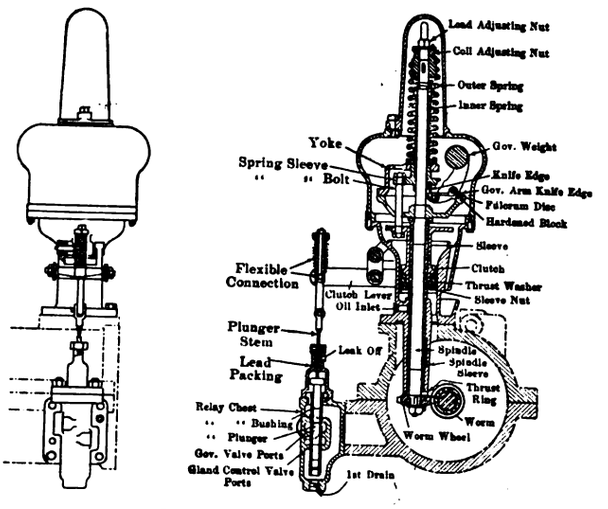

Fig. 23.—Turbine Governor

ernor worm chamber and thence to the pedestal oil drain space.

The fore and aft position of the turbine spindle may be checked at any time by means of the spindle indicator which is mounted on the forward end of each turbine. It consists of a pin extending through the end cover plate and rubbing against the retaining nut on the end of the shaft. The movement of this pin is multiplied by means of a pointer, so that the travel indicated is about five times the actual movement of the spindle. When not in use the indicator pin is pulled back out of contact with the spindle nut so as to prevent wear. However, it should be mentioned that the contact surface is so well lubricated by the oil inside the housing that frequent use of the indicator does not result in any appreciable wear.

All parts of the turbines and piping in which water is likely to collect are connected by drain pipes to a small steam ejector which delivers this water into the condenser. This ejector is necessary on account of the condenser being located at a higher level than the turbine.

To guard against the possibility of the turbines over-

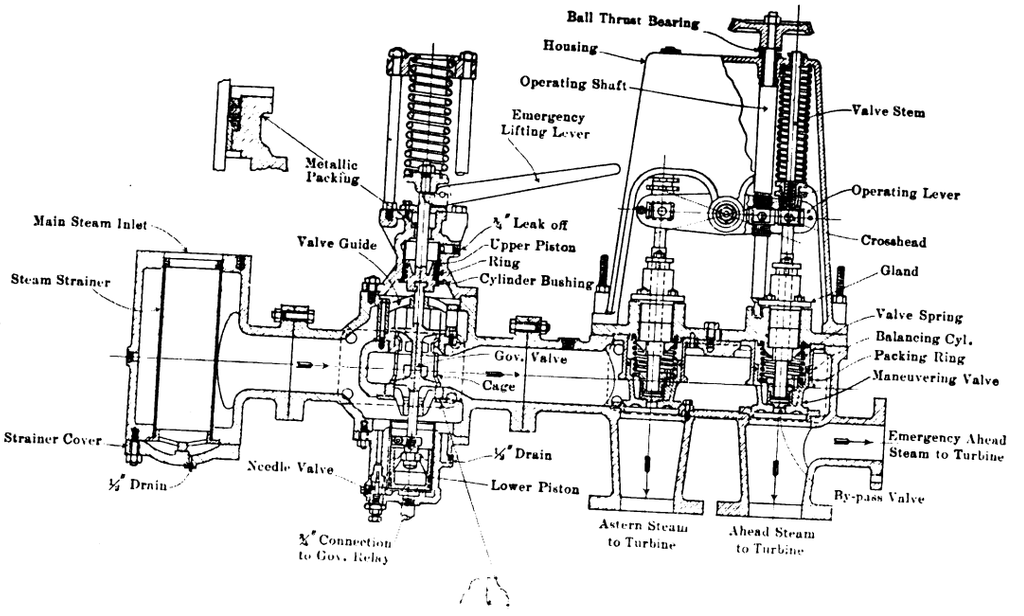

Fig. 24.—Maneuvering Valve, Governor Valve and Strainer

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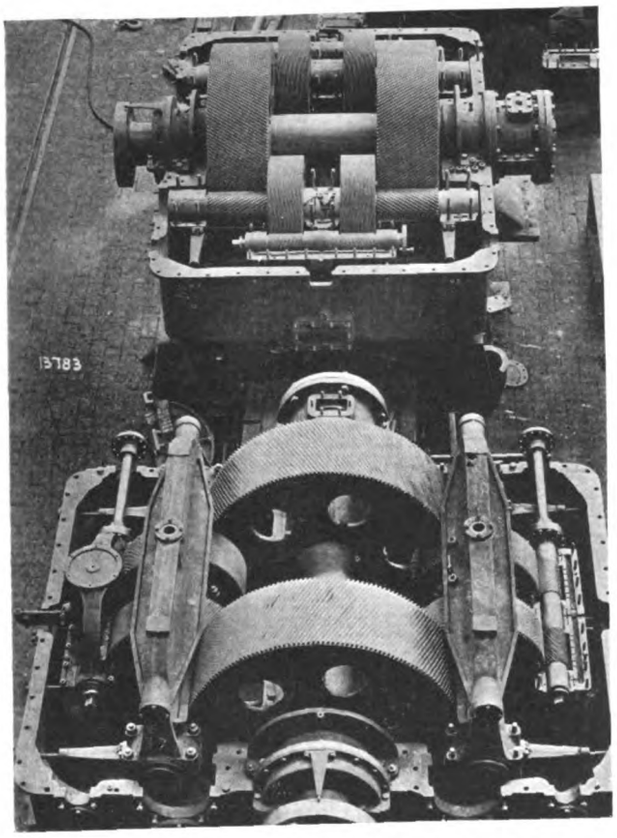

Fig. 25.—Reduction Gears with Cover Removed

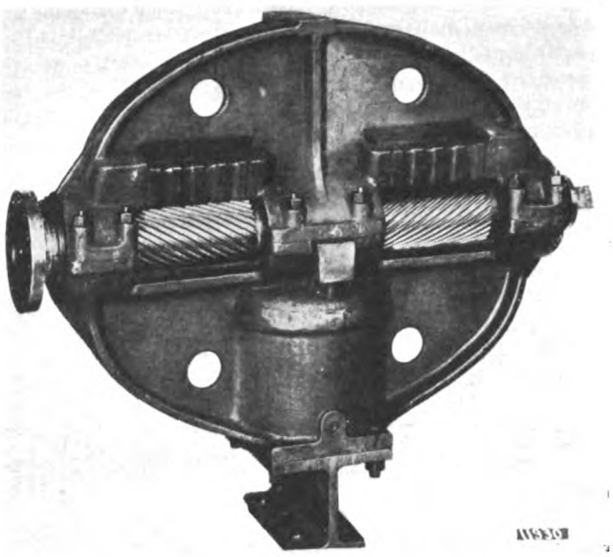

Fig. 27.—First Reduction Pinion Frame, Showing Flexible I-Beam Support

speeding, due to the breakage of a shaft or *"racing"* in rough weather, there is included on each machine an emergency overspeed governor, by means of which the turbine speeds are always held within safe limits, although under no conditions are they shut down entirely.

The arrangement consists of a vertical spindle mounted on the forward end of each turbine, driven by a worm wheel from the main shaft at a speed of about one quarter of that of the main shaft. At the top of this spindle is mounted a fly ball governor, the motion of which is transmitted through a system of levers to a small steam relay piston valve, which in turn regulates the steam pressure in the operating cylinder of the main governor valve.

The governor valve is located in the main steam line on the boiler side of the maneuvering valve between that and the strainer. It consists of a double disk balanced poppet valve with operating pistons at the top and bottom of the valve stem, and an external spring on top, the function of which is to prevent the valve from hunting rapidly.

The admission of steam to the ahead and astern turbines is controlled by two balanced throttle valves, both of which are contained in one body and operated by the same hand wheel. Turning the wheel in one direction

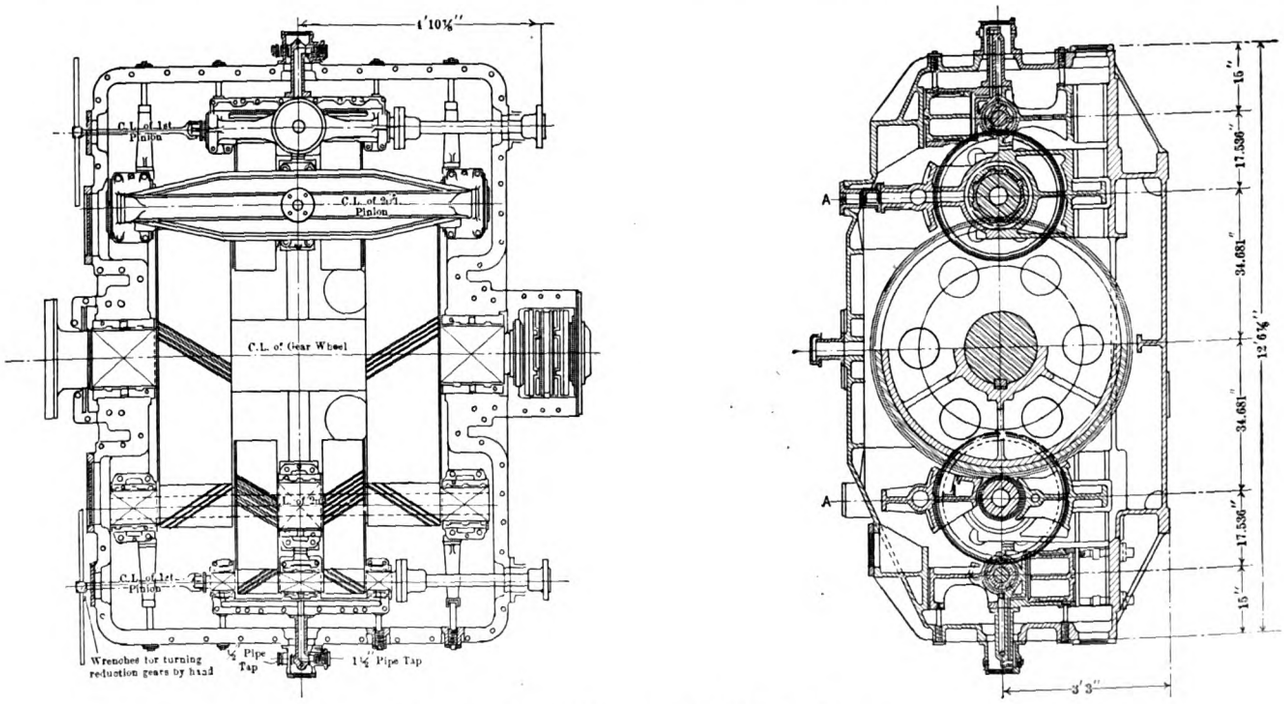

Fig. 26.—General Arrangement of Reduction Gears

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admits steam to the ahead nozzles, and in the other direction to the astern nozzles, it being impossible to open both valves at the same time. As the valves are single-seated (balanced by auxiliary piston), absolute tightness can be readily maintained.

A perforated sheet steel cylindrical strainer in a cast steel shell is fitted in the main steam line between the boilers and the turbine valves to protect the valves and turbines from the admission of any foreign substances.

In order to increase the overall economy of the complete installation, the exhaust steam from the auxiliary apparatus, having a pressure somewhat above atmosphere, can be used to advantage in the low-pressure turbine, and a suitable connection on the cross-over receiver pipe is provided for this purpose. A constant pressure valve is interposed, which automatically admits to the turbine any excess of auxiliary exhaust steam not used in the feed heater, and thus keeps the pressure in the auxiliary exhaust header approximately constant.

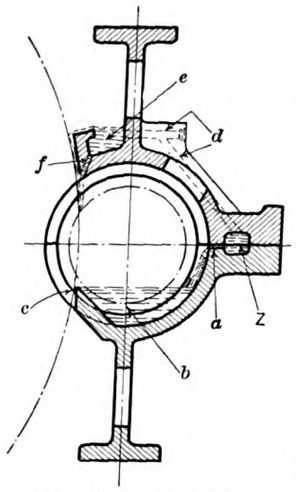

Fig. 28.—Section Through Pinion Frame, Showing Method of Lubrication

The main high-pressure steam piping is of steel and the cross-connecting piping between the turbines is of cast iron. Likewise the main exhaust trunk from the low-pressure turbine to the condenser is of cast iron. Between the exhaust trunk and the low-pressure turbine, and also in the cross-connecting piping, are located copper expansion joints, which prevent any external strains from being transmitted to the turbine casings.

The turbines are connected to the high-speed pinions by means of flexible shafts and pin couplings, which allow sufficient movement of the pinions to insure uniform distribution of the tooth pressures.

The pin type coupling consists of two coupling sleeves which are pressed and keyed onto the turbine spindle and pinion driving shaft respectively. Bolted to the coupling sleeve of the pinion and extending over and centering on the coupling sleeve of the turbine spindle is the coupling head. On the turbine end of this head are mounted twelve pins, which engage corresponding bronze bushed holes in the coupling head on the turbine spindle. Clearance is provided at each end of these pins and also in the bronze bushed holes, so that the pinion is perfectly free to slide axially without imposing stress on either turbine or gears. The bronze bushings are lubricated by oil, which spills out of the bearing and falls into a centrifugal lubricator formed in the coupling head. Holes are drilled from this lubricator to each bronze bushing. In a similar manner the sliding fit between the coupling head and the coupling sleeve at the turbine end is lubricated.

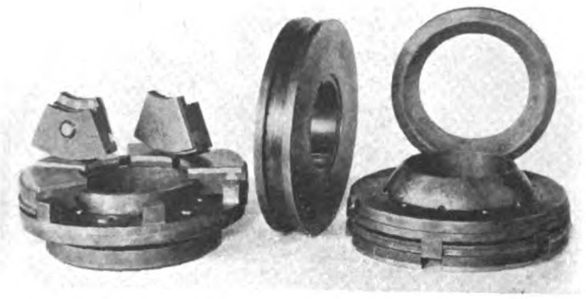

Fig. 29.—Parts of Kingsbury Propeller Thrust Bearing

Reduction Gear

The double reduction gear is of the Westinghouse flexible frame type, the pinions and gears being double helical with standard involute teeth. Each pinion is carried on three bearings mounted in a frame, which is made rigid enough to maintain the three bearings in alinement. This frame is supported at the center by an I-beam placed at right angles to the axis of pinion, and the flexing of the vertical web of the I-beam allows the whole frame to rotate a slight amount in a vertical plane. This automatically maintains the alinement of the pinion and gear, producing a uniform distribution of tooth pressure over the entire length of the tooth face, even though the gear case be distorted due to weaving of the ship's structure.

The ends of the pinion frames are held in correct position with reference to the gear axis by horizontal struts between the frame and the housing.

The pinions are made of forged steel, heat treated, and

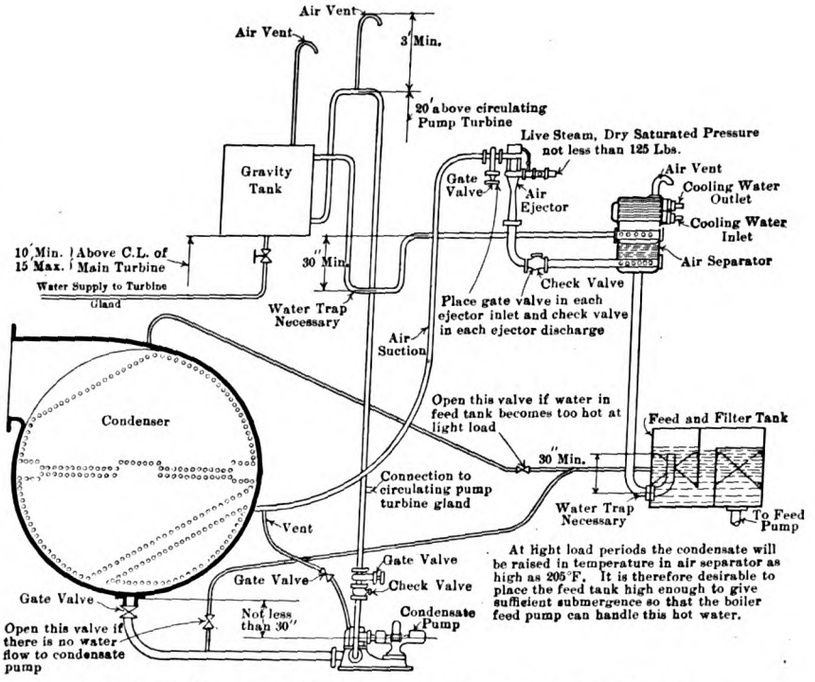
Air Vent
Air Vent
3' Min.
20' above circulating Pump Turbine
Live Steam, Dry Saturated Pressure not less than 125 Lbs.
Gravity Tank
Gate Valve
Air Ejector
Air Vent
Cooling Water Outlet
Cooling Water Inlet
Air Separator
10' Min. } Above C.L. of
15' Max. } Main Turbine
Water Supply to Turbine Gland
30" Min.
Check Valve
Water Trap Necessary
Place gate valve in each ejector inlet and check valve in each ejector discharge
Air Suction
Open this valve if water in feed tank becomes too hot at light load
Condenser
Feed and Filter Tank
30" Min.
Connection to circulating pump turbine gland
Water Trap Necessary
To Feed Pump
Vent
Gate Valve
Gate Valve
Check Valve
Gate Valve
Not less than 30"
Condensate Pump
Open this valve if there is no water flow to condensate pump
At light load periods the condensate will be raised in temperature in air separator as high as 205°F. It is therefore desirable to place the feed tank high enough to give sufficient submergence so that the boiler feed pump can handle this hot water.

Fig. 30.—Diagram of Westinghouse LeBlanc Condensing Equipment

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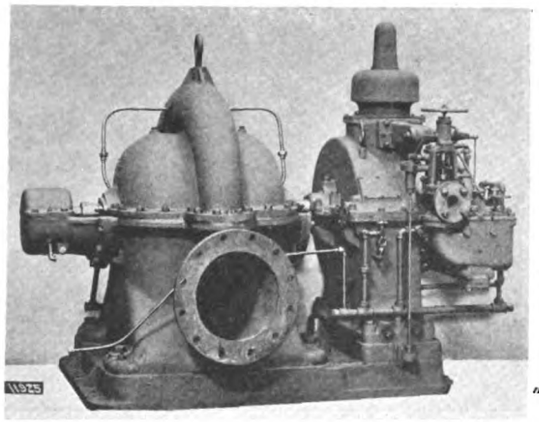

Fig. 31.—Main Circulating Pump Unit

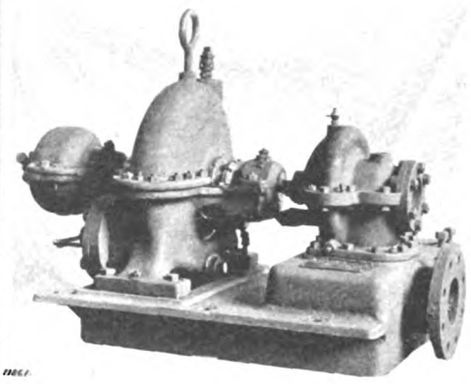

Fig. 32.—Condensate Pump Unit

Fig. 33.—Air Ejector

the gear wheels are built up with heavy cast iron centers and rolled steel rims. The high-speed gear wheels are mounted on the low-speed pinion shaft. The second reduction gear wheels are mounted on a heavy forged steel shaft, which couples directly to the propeller shafting.

All bearings are made up of a heavy cast iron shell lined with genuine Babbitt metal. The bearings are split on the horizontal centerline and oil is admitted through a machined passage in the joint.

The method of lubricating the gear teeth is shown in Fig. 28. The frame is designed to have the pinion dipping in oil at the bottom, the oil pan *b* being supplied with oil through holes *a* drilled at the joint of the frame into the main oil supply passage *z*. With the pinion revolving in a clockwise direction looking at the figure, the oil is swept

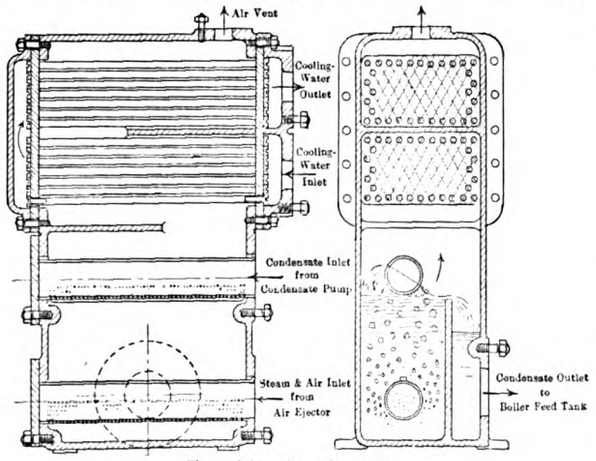
Air Vent
Cooling-Water Outlet
Cooling-Water Inlet
Condensate Inlet from Condensate Pump
Steam & Air Inlet from Air Ejector
Condensate Outlet to Boiler Feed Tank

Fig. 34.—Air Separator

from the lip *c* directly into the tooth mesh. Running in the opposite direction oil is supplied from a trough *c*, which is supplied through passage *d*. Holes are drilled in the bottom of this trough for proper distribution of the oil.

With this system of lubrication no oil pipes are required inside the gear case. All oil passages are large, precluding the stoppage of oil. The only small holes through which the oil has to pass are at *f*, and if these become clogged the oil merely overflows the trough and drops between the teeth.

In each high-speed pinion frame is incorporated a hydraulic dynamometer. To measure the horsepower being transmitted, the tooth pressure is balanced by oil pressure in the dynamometer cylinder, and, knowing the oil pressure and area of the piston, together with the diameter and revolutions per minute of the pinion, the horsepower can be determined.

Propeller Thrust Bearing

The propeller thrust bearing is of the Kingsbury segmental type, mounted on the main gear shaft at the forward end of the gear. It is contained in a housing which is solidly fastened to the main gear housing.

The thrust block is shown in the center of Fig. 29, consisting of a steel collar keyed to the gear shaft and held in position by a nut. This collar rotates between two sets of Babbitt-faced thrust shoes. These shoes are fitted at the back with a hardened steel button, each of which rests on a hardened steel piece in the spherically seated base ring. One base ring takes the thrust when going ahead; the other when going astern.

The bearing is always flooded with oil in circulation, this being an essential feature for its satisfactory performance.

Condenser Equipment

The main condenser is of the latest Westinghouse type, designed for producing high vacuum. It is constructed with a cylindrical cast iron shell, Muntz metal tube plates and Admiralty metal tubes. The cooling water makes two passes.

The cooling water is supplied by a centrifugal, geared, turbine-driven pump having a normal capacity of 4,000 gallons per minute. The turbine is designed to develop about 52 horsepower and operates with a steam pressure of 175 pounds per square inch gage, and a back pressure of 10 pounds per square inch gage. It consists of a single high-speed impulse wheel, with a reversing chamber, by means of which the steam is made to pass through the wheel a second time.

The reduction gear is of the double helical type, consisting of a single pinion with fixed bearings and on the main shaft is mounted the governor which controls the speed of the unit. The turbine spindle and pinion are made as one piece, supported on two bearings. Water seals are provided on the turbine shaft to prevent leakage of steam where the shaft passes through the turbine casing. The gear reduces the speed of the turbine from 6,900 to 575 revolutions per minute.

The pump itself is constructed with a cast iron body and a bronze runner mounted on a bronze encased steel shaft. Glands with flax packing, provided with a water seal, are fitted over the shaft at each end of the pump casing to prevent leakage. The main gear is mounted on the same shaft as the pump runner, which is supported by two bearings, the gear being overhung.

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Lubrication of the entire circulating pump unit is provided from the main lubricating oil system.

There are two condensate pumps located beneath the condenser for extracting the condensate from the condenser. Each pump is of sufficient capacity to handle all the water at full power, the other being a standby for emergency use. These are centrifugal pumps, direct turbine driven. The pump runner and the turbine rotor are both mounted on the same shaft supported by two bearings, the pump runner being overhung.

The pump casing and runner are of bronze; the portion of the spindle contained inside of the casing is enclosed in a bronze sleeve.

At the point where the shaft passes through the pump casing there is fitted a packing gland, using flax packing and sealed with water from the discharge side of the pump chamber.

The turbine is of the single-wheel impulse type, similar to that driving the circulating pump, with bearings of the ring-oiled type. The spindle glands are fitted with a special form of adjustable metallic packing.

On the turbine end of the shaft is mounted a centrifugal governor, which operates a balanced throttle valve and so controls the speed of the machine. The turbine is designed to operate on a steam pressure of 175 pounds per square inch gage and a back pressure of 10 pounds per square inch gage. The normal speed is 2,700 revolutions per minute and there is developed about 5½ horsepower.

The condensate is discharged into a gravity tank, from which is taken the gland sealing water. From the gravity tank the condensate flows to the air separator and thence to the feed tank.

The air separator is virtually a jet condenser for condensing the exhaust steam from the air ejectors, the main condensate being used as cooling water. The air escapes to the atmosphere through a vent at the top, and to prevent the egress of objectionable vapors a small surface condenser is included in the top of the separator tank, for which cooling water is supplied from the main circulating system.

Two Westinghouse LeBlanc air ejectors are installed to extract the air from the condenser, either of which is of sufficient capacity to meet full load conditions, the other being provided as a spare. The air is withdrawn by means of multiple jets of steam in series which compress the air to atmospheric pressure. The mixture of air and steam passes into the air ejector tank, where the steam is condensed and the air escapes to the atmosphere.

By using air ejectors in place of air pumps, a very much simpler arrangement is obtained, which, besides requiring less attention in operation, takes up considerably less space. The ejectors are made of bronze, and are designed to operate on any steam pressure above 125 pounds per square inch gage.

The auxiliary condenser is cylindrical in shape, containing 800 square feet of cooling surface. Cooling water is supplied and the condensate and air removed by a combined circulating and wet air pump furnished by Dean Brothers.

PROPELLER SHAFTING

The main line shafting consists of six lengths of solid, forged steel, 13¼ inches in diameter and 23 feet 2 inches in length, fitted together with flanges and taper bolts.

The flange couplings are so designed that they may be readily held in perfect concentricity while the bolt holes are being reamed, and yet when finished there is no spigot fit to prevent one length of shafting from being lifted out without disturbing the adjacent units. This is accomplished by counterboring both halves of the coupling and inserting a well-fitted plug which remains in place during the reaming process, after which it is removed.

The coupling bolts are made with a moderately small

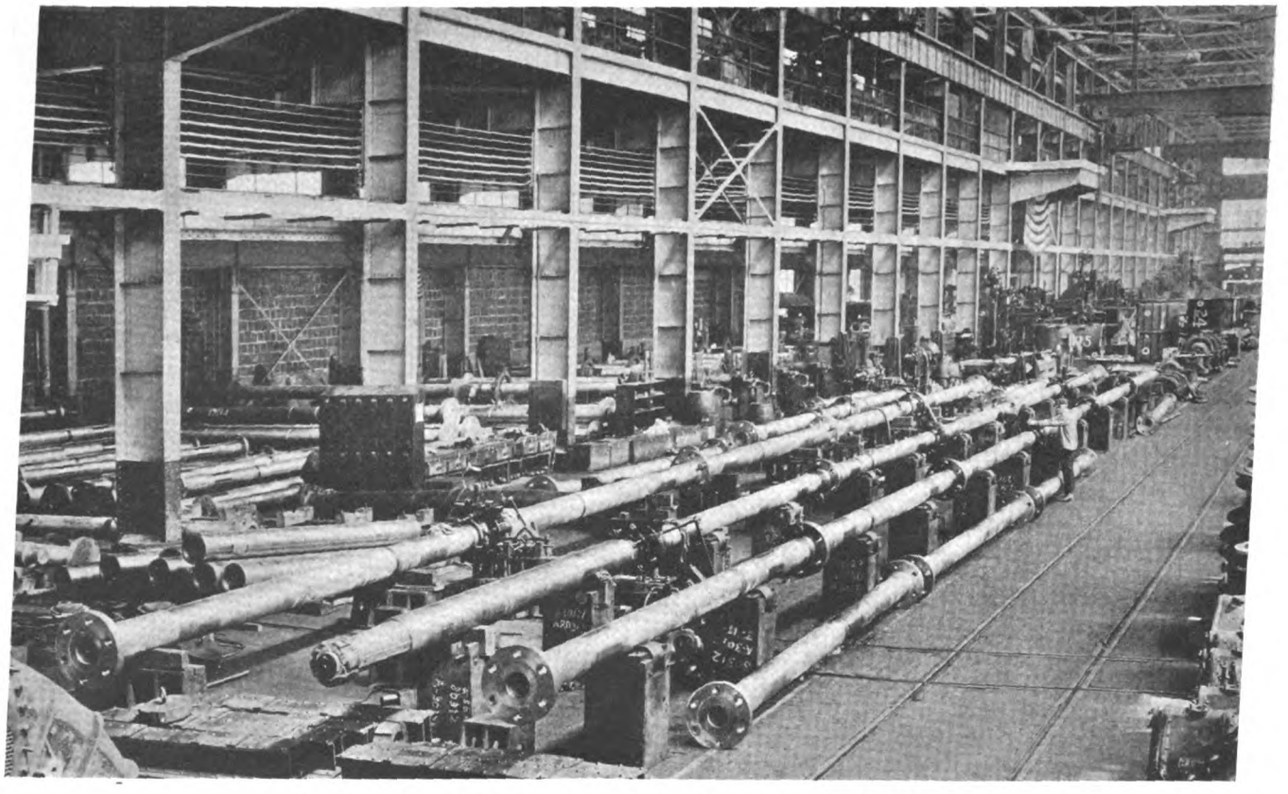

Fig. 35.—View Showing Line Shafting Set Up in Westinghouse Shops

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taper so as to insure that the flanges will be properly drawn into place each time they are reassembled, and instead of having heads, the bolts are fitted with a nut at each end. The nut on the large end serves as a lock nut when the bolt is in place and gives additional power for holding the flanges together. Furthermore, it affords a very convenient method of backing out the bolt when disassembling.

Each length of shafting is supported by two ring-oiled bearings 18 inches long. The ring-oiling feature, although new in its application to marine line shaft bearings, is, of course well known in engineering practice, and the operation of the bearings on all of the ships in service has been unqualifiedly successful.

The tail shaft is 17 feet 6¼ inches overall, covered for almost its entire length by a bronze sleeve, shrunk in place.

The stern tube consists of a cast iron casing 9 feet 10½ inches long, in which are fitted two bronze liners with ligmum vitae bushings.

Machinery Weights

The actual weights of the various units of Westinghouse equipment are as follows:

	Pounds
Main high-pressure turbine	13,520
Main low-pressure turbine	17,270
Main reduction gear	63,800
Main steam strainer, 6 inches	350
Maneuvering valves, 6 inches	1,310
Cross-connecting piping and valves, including the four valves which control the emergency live steam	9,000
Main exhaust trunk	12,000
Main exhaust trunk expansion joint	120
Main condenser	29,600
Circulating pump unit	6,270
Two condensate pumps	2,040
Two air ejectors	180
Air separator	780
Auxiliary condenser, without pumps	7,250
Six lengths of line shafting and tail shaft	82,000
Twelve line shaft bearings	13,680
Sterntube	7,200

S.S. Guimba Hits a Mine

DESPITE the strenuous efforts of the mine sweepers, navigation in certain localities still remains extremely hazardous. The colossal tonnage loss sustained during the war is being added to by the presence of mines. Some idea of the danger that our ships have to contend with may be formed when it is stated that one ship alone reports having seen some seventy drifting mines within a comparatively small radius.

Of five United States ships that have struck mines since September, 1919, the S. S. *Guimba* was the only one saved, and this, it is said, is due to the fact that she was sailing only under sand ballast.

This ship is a steel refrigerator steamer of 6,149 gross tons and was built by the Moore and Scott Iron Works at Oakland, Cal. Her length overall is 416 feet 6 inches, her beam 43 feet, and depth 34 feet 6 inches. Propulsion is by Westinghouse compound turbines of 2,800 shaft horsepower. Two compressors of 80 tons capacity are used for refrigerating purposes.

The *Guimba* sailed for Hamburg on September 26, 1919, and, after unloading her cargo of frozen meat, left that port on October 18 on her return for the United States.

At half past two on the morning of the 19th, when some eighteen miles from the mouth of the river Elbe, a mine was encountered and a severe explosion took place. No. 1 bulkhead at her bow immediately admitted water, but, fortunately, No. 2 bulkhead was undamaged, and, despite the darkness and confusion, the ship was at once headed about and succeeded in making port at Hamburg. Here she was put in dry dock and it was discovered that a hole of about 18 feet by 24 feet on the port side and two smaller holes of about 3 feet by 4 feet each on the starboard side had been blown in.

Hole 18 by 24 Feet Torn in Port Bow of the *Guimba* by a Drifting Mine

Repairs were made in 18 days, and eventually the *Guimba* sailed for New York, where subsequently she was docked.

Considerable credit is reflected upon Chief Engineer E. A. Partsch, a member of M. E. B. A. No. 13, for his energy and ability in contending with this emergency, and it is certainly a matter of congratulation to all concerned that it was not necessary to write this ship off as a complete loss.

A Practical Blue-Print Protector

Blue-prints are always getting dirty, wet, greasy or torn while being handled by workmen using them. An inventive genius has designed a very practical blue-print protector of simple construction and low cost. A sheet of transparent sheeting—the same material used for lights in auto curtains—is cut to desired size. A piece of lightweight leather substitute is then cut about a half-inch larger all around than the piece of sheeting. This extra half-inch allows for a lap-over on all but the top side of the protector. A sewing machine stitches the lap down to the sheeting, forming a large flat pocket, open at the top for the insertion of the blue prints.

Both the transparent front and the coated fabric back are water-proof and grease-proof. Dirt or grease may easily be wiped or washed off, either without injury to the material. Both materials are flexible and the holder may be rolled up if desired in the same way as an unprotected blue-print is usually handled by a workman.

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Congress and the Merchant Marine Issue

BY WALDON FAWCETT

While there is not essentially and necessarily a close parallel between the general problem of railroad transportation in the United States and the principles and policies governing the nation's water-borne commerce, it is impossible to avoid comparisons just at this time, when the future of both elements is in a state of flux. In all candor may it be said that, despite the diversity of the interests involved, the development of a Congressional conscience with respect to the merchant marine should not be as slow a process as the building of a railroad "platform" were it not for the fact that the interests of labor enter into the one as into the other. Significant in that connection is the disclosure during the past month of the project of a certain political element to make government ownership—not merely government ownership of the railroads, but Federal operation of all public utilities and like enterprises—an issue in this year's Presidential campaign. As our readers fully realize, the issue of labor is a vital one not only for our shipbuilding interests, that will be called upon to meet sharpened competition from Japanese builders, but likewise for American shipping interests that felt, long before the war, the pinch of hampering exactions covering the human equation in ship operation. Just in proportion, therefore, as the labor issue enters, and just in proportion as a conclusive solution of that issue waits, will there be haze on the horizon of our merchant marine.

IN one respect the merchant marine situation in Congress has been clarified, namely, with regard to the disposition in certain legislative quarters to link the merchant marine issue with that of tariff revision and make the one, in certain respects, dependent upon the other. For some of the practical men in the shipping and shipbuilding industry it has been difficult to discern any pronounced interdependence between the problems of the American merchant marine and the system of United States customs duties, even though as an annex to the latter we have the proposition for "free ports" or "free zones." However, there has been at the Capitol a certain sentiment that favored consideration of the one responsibility in connection with the other. Therefore it is significant that the leaders in Congress have virtually decided that no general revision of the tariff schedules will be attempted during the year 1920, and that, in consequence, whatever action is taken in contemplation of the needs and possibilities of the Yankee merchant marine must be without regard to a change of tariff status.

Crystallization of popular sentiment on the merchant marine issue has not waited wholly upon the 1920 hearings before the commerce committee of the Senate which are counted upon to supply the best forum yet afforded for debate of the questions involved. On the eve of the opening of these hearings came the report of the referendum on a national merchant marine policy conducted by the Chamber of Commerce of the United States as a medium for the expression of the sentiment of the 1,200 trade and commercial organizations comprising the Chamber's membership.

The Effect of "Straw Votes"

In view of the overwhelming vote in favor of a general declaration by Congress of a policy to give aid to the maintenance of a privately owned and operated American merchant marine and for the continuance of operation of the competent American shipbuilding yards on private account, the question may be solicitously raised as to the weight which such pronouncements carry with the Congressmen who are ultimately called upon to vote on the propositions recommended. Generally speaking, it is to be feared that such "straw votes" do not mold Congressional sentiment as they should—not because the legislators intentionally flaunt commercial opinions, but simply because, too often, the substance of such symposiums is not brought emphatically and insistently to the attention of each individual lawmaker. It is always difficult to persuade the rank and file of busy Congressmen to spare the time to read carefully the voluminous record of Congressional committee hearings (such, for example, as the merchant marine hearings now in progress under the auspices of the Senate commerce committee), and it may be surmised that, with bodies all over the country constantly "resolving" on this subject, and that it requires a peculiar talent in insistence to impress indelibly upon the Congressional mind "memorials" bearing upon the merchant marine such as have come, latterly, not only from the National Chamber of Commerce but from other mouthpieces of big and little business.

Features Virtually Approved

On some of the incidental features of the merchant marine programme—for example, the proposition to give preference to American underwriters and the proposals for the encouragement of the American classification society—the powers that be in Congress are definitely "sold" and the enactment of enabling legislation seemingly waits only upon Congressional routine rather than halts before active opposition. The action of the framers of railroad legislation in striking out the provisions that would have extended the full measure of Federal supervision to inland waterway and coastwise shipping was, for the time being, eloquent of the growth in Congress of a sentiment for freedom on the part of the merchant marine from government regulation of routes and rates. Just so long, however, as any political element flirts with the idea of Government ownership will there be justifiable speculation as to the immediate and ultimate effect upon merchant marine policies.

It is by no means certain that the tentative proposal to stretch the railroad regulatory measures to encompass shipping has not proven, in one sense, a blessing in disguise. Raising of the issue has brought to Congress a wealth of first-hand information on the conditions and problems of American inland waterway and coastwise commerce that would not, perhaps, have been acquired in any other way and that may prove valuable in the

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determination of all public policies affecting this important section of the nation's water-borne commerce. Distinctly illuminating, for example, have been the data assembled with respect to shipping and shipbuilding on the Great Lakes—a section of the industry whose importance was so strikingly attested during the world war.

Interests operating "wild" boats on the Great Lakes have strongly endorsed the contention of their brethren who operate "tramp" vessels on the ocean to the effect that there should be exempted from all Federal jurisdiction as to rates the "port to port" traffic the compensation for which has, from time out of mind, been determined by the Yankee process of bargaining. In like manner has it been urged that a corresponding immunity should extend to the port-to-port business of the lines operating on regular schedule, but which are required, in the case of upward of 50 percent of their cargoes, to come into direct competition with the "wild" or "tramp" steamers. It has even been suggested that an equitable adjustment of this shipping situation would require not merely an absence of new legislation on the subject, but likewise a modification in some respects of the jurisdiction already exercised by the Interstate Commerce Commission. Generally speaking, though, the attitude of the shipping interests of the Great Lakes, as translated to Washington, has been favorable to a status that would avoid any disturbance of the conditions heretofore existing—a status the continuance of which was, in effect, approved when the Shipping Act, that was placed on the statute book several years since, expressly exempted the bulk freighters. Quite equal to the representations with respect to Great Lakes shipping has been the impression left with Congress of the necessity for reasonable elasticity in rate making on the part of the coastwise lines.

Responsibilities of Water and Rail Carriers

Certain coastwise shipping interests, notably those engaged in the Alaska trade, have been at pains to make it clear to Congress that one ground for fear of the consequences of an extension to shipping interests of the full jurisdiction of the Interstate Commerce Commission is found in the responsibilities that would be imposed through what is known as the Cummins amendment to the Interstate Commerce Act, an amendment providing that all carriers subject to the act shall be liable for the full value of any loss or damage to goods in transit. The discussion in this connection has opened up the whole subject of the relative responsibilities of water carriers and rail carriers, the judicial aspect of which issue will probably shortly be disposed of in test cases now pending in the Federal courts. Naturally, the shipping men who have been appraised of the situation have viewed with misgivings any prospective turn of affairs that would disturb the different standard of liability which the leading maritime nations of the world have heretofore recognized for water carriers in contrast to that enforced upon land carriers.

One class of shipping interests, namely, those concerned with the utilization of the transportation facilities of the Mississippi river and tributary waterways, has seized upon the opportunity afforded by the discussion of the issue of railroad control to bring forward an entirely different issue, viz., the alleged repressive effects of railroad competition upon river commerce. Representatives of the Mississippi Valley Waterways Association and similar organizations appearing before Congressional committees have charged that the railroads have been permitted to make such "low and ruinous" rates to river points as to make it unprofitable for boat lines to operate upon the rivers, the losses thus incurred by the railroads being made up to them through the imposition of high rates to inland points. It having become evident that Congress is in a mood to overhaul the railroad legislation now on the statute books, the river shipping interests have come forward with the plea that new or supplementary legislation be enacted that will compel the railroads to recognize the inland waterways transportation interests as common carriers and to co-ordinate and co-operate with them as the railroads do with one another. Apropos this same agitation we have bills now pending in Congress to transfer the transportation on the lower Mississippi and that which is expected to be developed on the upper Mississippi to the United States Shipping Board.

Inland Waterway Navigation

It is not improbable that the mere circumstance of the return of the railroads to private management on March 1, irrespective of the exact terms of the railroad legislation that will be agreed to in the meantime, may operate indirectly to bring to a head the long festering issue of the proper capitalization of American inland waterways as arteries of commerce. During the past few years there has been more or less activity in the field of inland waterways shipping on the part of the Inland Waterways Division of the Railroad Administration. With the return of the railroads these arrangements will necessarily come to an end and there will be increased insistence on the part of persons directly interested that some definite steps be taken to restore the rivers to their old position as highways of commerce. Various proposals to this end have already been formulated, including the project which has been before Congress for some time past for the creation of a permanent inland waterways commission. Hung up with the general issue in this same connection is the question of adequate terminals, which is accounted by many shipping men the tender spot of the whole subject. The Railroad Administration has had in contemplation the provision of suitable terminals at strategic points, say at Cairo, Ill., and now, if the withdrawal of the Railroad Administration ends initiative in this quarter, the responsibility will be thrown back upon the cities which, with the exception of New Orleans and St. Louis, have not responded as they might to the need for terminals.

As pertinent, in view of the prospective return of the railroads to private management, it may be worth while to give a glance in passing to what has been accomplished by the Inland Waterways Division of the Railroad Administration, an institution that has functioned in two sections, namely, the New York Barge Canal Section and the Mississippi and Warrior River Section. In the case of the first-mentioned section expenditures have aggregated in the neighborhood of $4,500,000 (£925,000), providing for the construction of 51 steel and 21 concrete barges, 21 self-propelled steel barges and the purchase of 5 tugs and 3 barges. On the Mississippi-Warrior Section the authorized programme has called for upward of $10,000,000 (£2,050,000), this being designed to provide 6 towboats and 40 steel barges of 2,000 tons deadweight capacity, which are now being delivered at the rate of 5 or 6 a month, in addition to a number of wooden barges. A complete fleet of the new boats cannot be available before next summer, and there will be regret if any circumstance interferes to prevent a try-out on the lower Mississippi of the tow and barge system under favorable conditions.

Settlement of War Claims

During January the builders of wooden ships, who are seeking redress from the Government on more or less

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"intangible" war claims, had their "day in court" before committees of both the Senate and House of Representatives, and the consequence is that the national legislature seems to be in a fair way to provide a basis of settlement for claims based on verbal agreements. This is not saying, however, that it may not be a matter of weeks before the Shipping Board is empowered to adjust the equitable claims of the wooden-ship builders. There are several different proposals before Congress on this issue, viz., the bill of Senator Jones of Washington, the measure introduced by Representative Greene of Massachusetts and the proposal of Congressman Johnson of Washington, and a certain amount of time will be required to iron out the differences or discrepancies between these several programmes, all of which aim at the same objective.

Admiralty Suits Against the Government

The past few weeks have also witnessed significant progress in the effort to obtain at Washington authorization for suits against the United States in admiralty, etc. This is a boon which has been earnestly sought by shipping interests speaking through the instrumentality of the Maritime Law Association of the United States, and the committee of the judiciary of the House of Representatives has been wrestling, in consequence, with the whole question of fixing the status of government-owned or operated vessels. Latterly, pressure has been strong for the extension of the scope of the contemplated legislation to cover naval vessels, army transports, etc., as well as merchant vessels. On the other hand, there has been encountered strong sentiment in the judiciary committee against affording any form of relief for maritime torts that might operate to tie up or interfere with the operation of naval or military craft in time of war. At this writing the outlook is for a compromise that will provide means for compensation to shipping interests for damages caused by negligent navigation of a public vessel of the United States, but that will be hedged with limitations that will preclude the possibility of interference with the operation of any Federal craft in time of emergency.

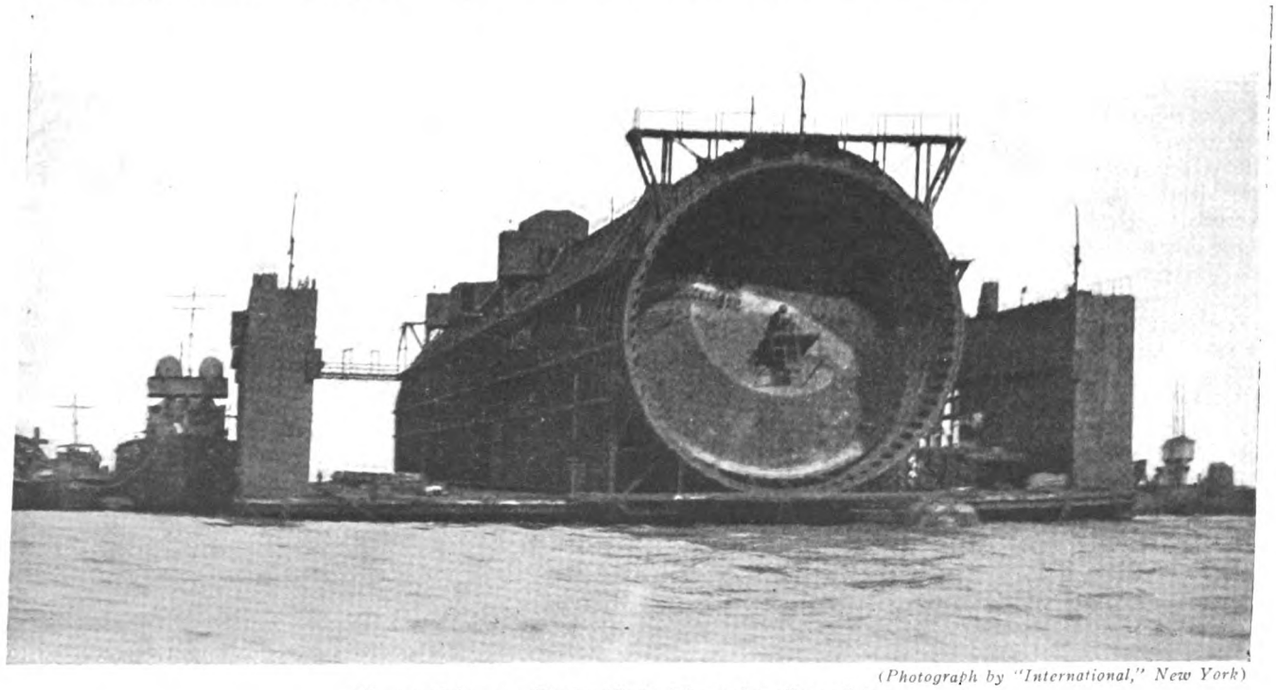
In contemplation of the formulation of a definite and permanent governmental policy on the general issue of the merchant marine, no little discussion has been precipitated in Congressional circles by the belated revelation to members of the facts presented some months ago to the Senate committee on commerce by J. H. Rosseter, director of operations of the Emergency Fleet Corporation. Director Rosseter made his disclosures in executive session, and it is only lately that it was decided to take the full membership of Congress into the confidence of the committee with respect to the evidence submitted.

Offsetting Higher Shipbuilding Wages

Director Rosseter discussed, among other things, the possibility of offsetting the world-wide tendency to higher wages in the shipping industry by improvement in the speed of vessels and improvement in the facilities for handling cargo, thus reducing the time in port. In answer to pointed questions he declared his confidence that, with all the Government vessels built or building turned over to private interests, American shipbuilders will be able to compete with foreign builders and American ship operators will be in a position to compete with foreign owners. But, he added, "We must have fair treatment for our ships. I have always contended that in the past, instead of encouraging, we have persistently discouraged the maritime enterprises of our people. We should now tear down that discrimination and replace it with a fair measure of encouragement."

Great Britain Secures German Submarine Testing Tank

WHEN Germany undertook to conquer the world by relentless submarine warfare she had as a part of her naval equipment a large cylindrical floating tank in which her submarines could be subjected to any desired pressure in order to test their strength and watertightness. By means of these tests the fitness of the vessel for submergence to predetermined depths could be ascertained without the hazard of sinking the vessel in deep water. This tank, which has been allocated to Great Britain, can be seen in the photograph below, lying at anchor in the harbor at Harwich, England.



(Photograph by "International," New York)

German Submarine Testing Tank Allocated to Great Britain

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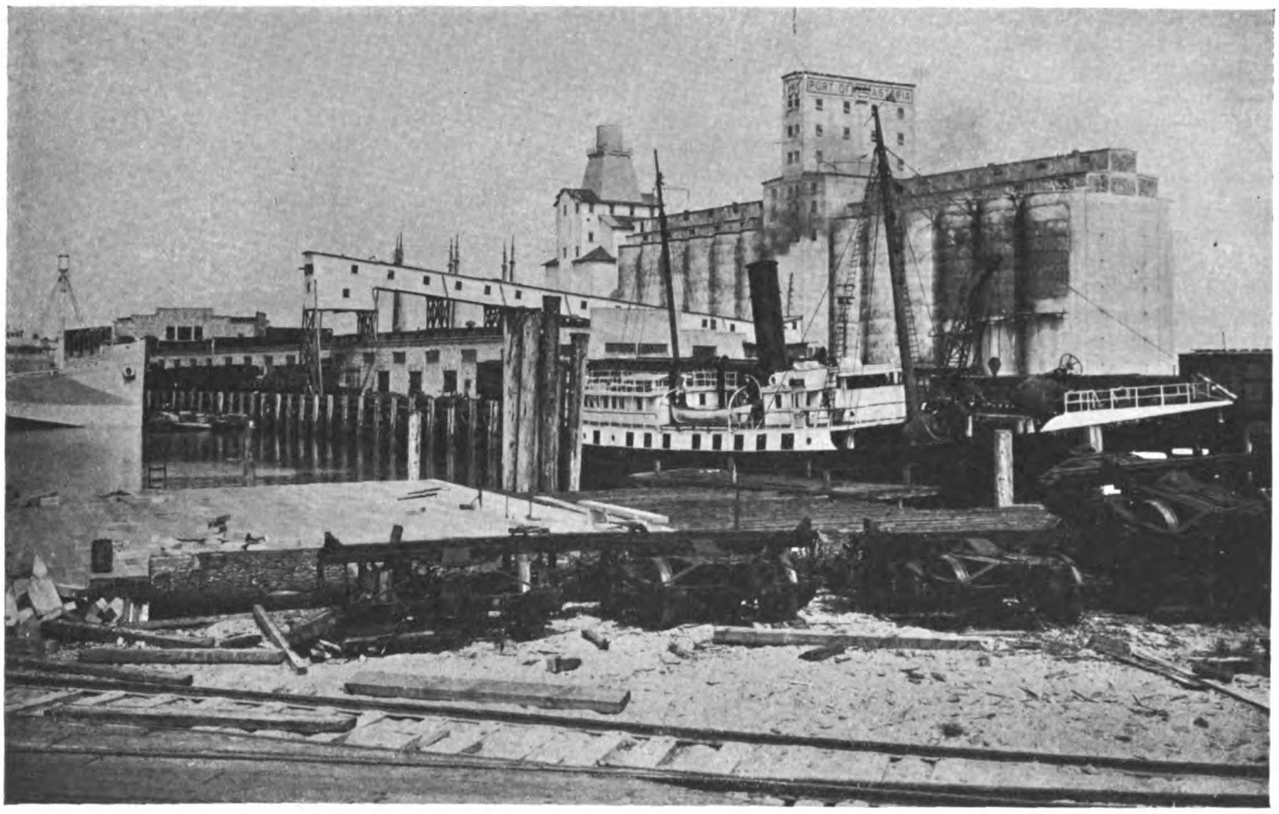

Fig. 1.—Bulk Grain Storage Plant of 1,200,000 Bushels Capacity on Pier 1

Shipping Facilities of the Port of Astoria*

As an example of the excellent shipping facilities which may be developed by careful planning in a harbor providing deep water, we give in this brief article an account of the construction work completed or in process at the Port of Astoria, Oregon. Her three broad piers over 1,000 feet long, two already in operation, will be threaded with conveniently located railroad tracks and equipped with the most modern types of handling machinery especially adapted to the needs of the material exported and imported through this harbor.—THE EDITOR.

THE Port of Astoria, located on a peninsula between Youngs bay and the Columbia river, ten miles from the ocean, is well situated for the development of extensive ocean commerce. The entrance to the harbor has a depth of 42 feet of water at mean low tide and the channel is 3,000 feet wide. Eight square miles of anchorage with a depth varying from 30 to 70 feet at mean low tide are provided, with an additional 12 square miles varying from 24 to 70 feet in depth. The harbor, which is fresh water, is free from ice and protected from swells by specially constructed jetties.

The total berthing space of the wharves in the harbor will be 11,714 linear feet—1,723 feet water frontage for Pier No. 1, 3,178 feet for Pier No. 2. Pier No. 3, for which the Foundation Company, New York, has recently received the construction contract, will have a berthing space of 3,875 feet.

DEVELOPMENT OF THE HARBOR

In 1913 a small tract of waterfront property comprising 56 acres near Smith's Point, on the main channel of the Columbia river, was purchased by the port commissioners. Upon this site Piers 1 and 2 have already been constructed. All wharves are served by the Spokane, Portland and Seattle Railroad Company in direct rail communication with the interior on a water level grade.

CONSTRUCTION DETAILS OF PIER NO. 1

Pier No. 1, which has a frontage of 620 feet, is 1,363 feet long, with a total area of 806,000 square feet entirely bulkheaded and filled in. Upon this pier are located a freight shed, a bulk grain and storage plant, extensive railroad trackage, a 4,000-barrel capacity flour mill, and additional freight sheds, providing 65,000 square feet of covered storage space. These sheds are equipped with mechanical ramps for loading and unloading commodities from barges and vessels. Eight portable conveyors are used for the handling of grain, flour and other bulk freight to and from the cars and to the ship's hold. Each of these conveyors handles a maximum load of 100 tons per hour, depending, of course, upon the labor available on the ships to stow away the cargo as it is loaded.

Chutes and sliding doors have also been constructed to load sacked freight into the holds. The 1,200,000-bushel

* This article has been prepared from data furnished by R. R. Bartlett, manager and chief engineer of the Port of Astoria, and by the Foundation Company, New York.

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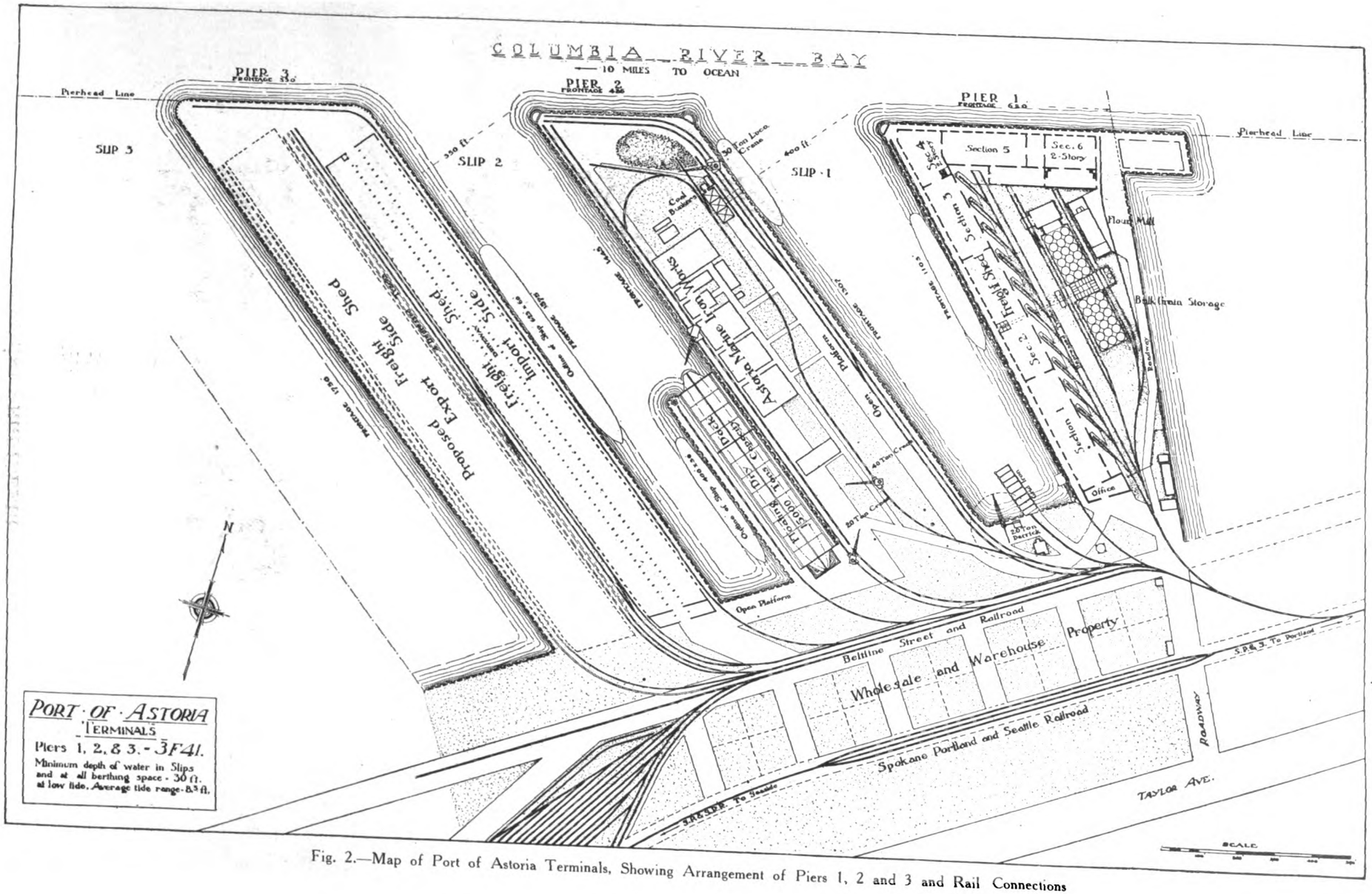

Fig. 2.—Map of Port of Astoria Terminals, Showing Arrangement of Piers 1, 2 and 3 and Rail Connections

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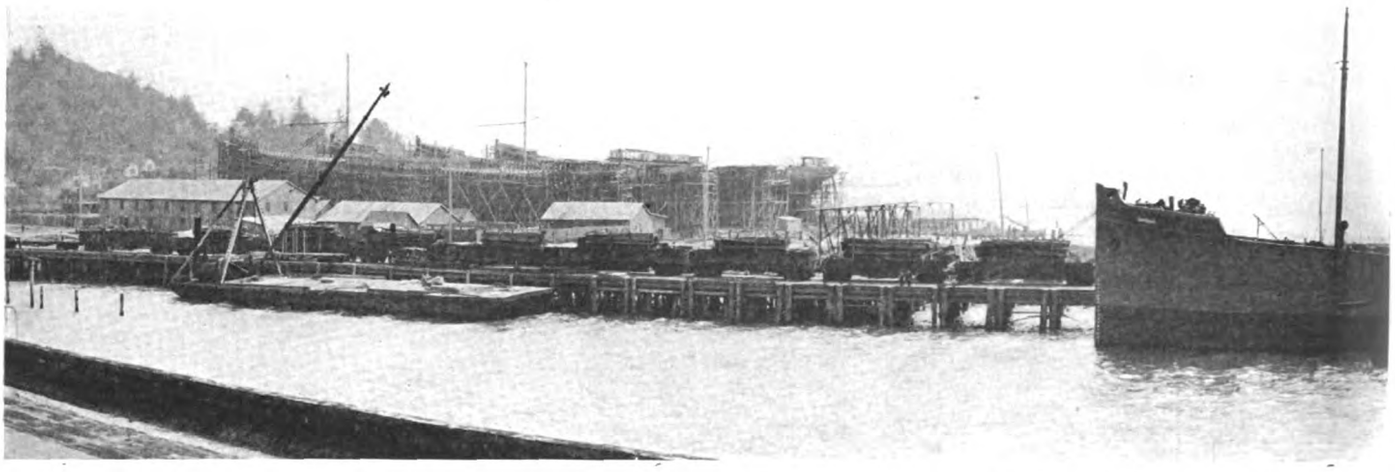

Fig. 3.—Panoramic View of Pier 2, Showing

Fig. 4.—Coal Storage Facilities

bulk grain plant, built of reinforced concrete, has been in operation since 1918. Two storage units are made up of 64 tanks; the main tanks are 28 feet 6 inches in diameter by 78 feet deep. The flour mill, a five-story structure, also of concrete, is now being built.

Mechanical pilers, trucks, catch-alls, slings, chutes and other mechanical devices are installed for unloading canned goods at the rate of 1,000 cases per hour. Automatic checkers are also used in this work.

The arrangement of the railway tracks makes it possible to place cars close to the water's edge for handling freight direct to the vessel's hatches. Three rail tracks are provided along the front of the dock. Depressed herringbone tracks of special design permit the unloading of three cars from one warehouse door. The bulk grain plant is served by four tracks. The total trackage on the pier will accommodate about 100 cars. Three locomotive cranes of 30, 40 and 50 tons each serve this pier.

Facilities of Pier No. 2

On Pier No. 2, which is 426 feet wide and 1,445 feet long, coal bunkers are operated over gravity discharge and apron conveyors to telescoping chutes, which deliver the fuel direct to the ships' bunkers. Cranes similar to those installed on Pier No. 1, with an additional electric

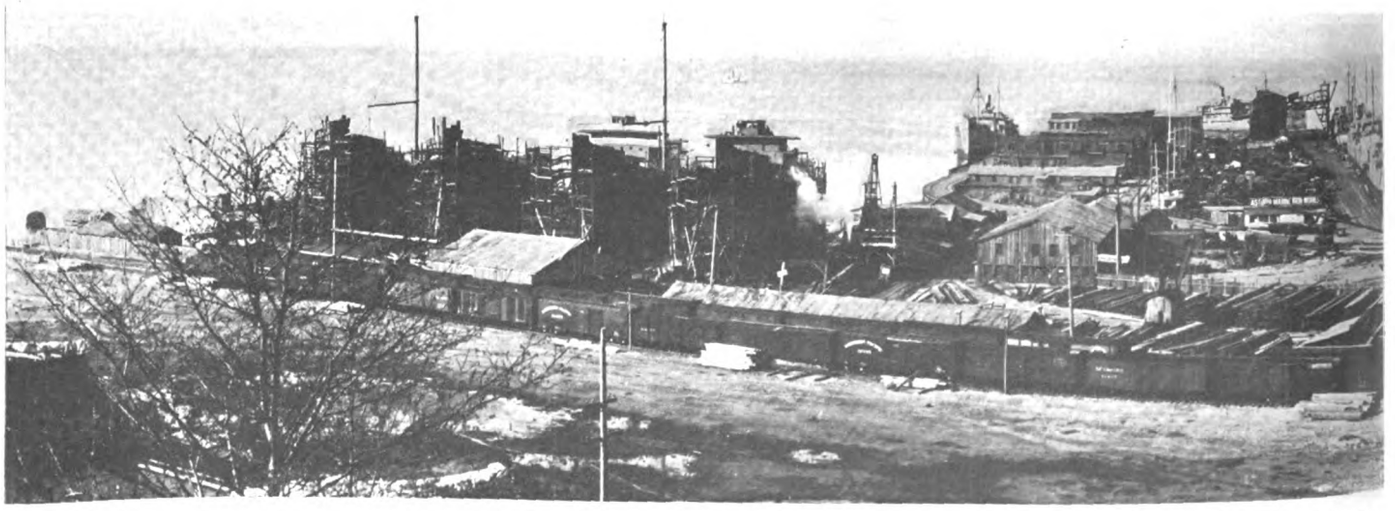

Fig. 5.—General View of Port of Astoria Terminals, Showing

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Its Great Length and Bunkering Facilities

derrick of 20 tons' capacity, handle lumber, coal and all classes of heavy package freight expeditiously. The railroad tracks are constructed on both sides of the bunkers and storage piles to facilitate unloading.

15,000-Ton Floating Dry Dock Planned

Plans are still under consideration for the construction of a 15,000-ton floating dry dock. In the plan of the terminals shown in the accompanying illustrations provision is made for the location of this dry dock in slip 2 off Pier No. 2, a sheltered location accessible to railroads and shops. This construction, however, has been temporarily held up until more urgent work has been put through. At present, repairs are handled by the Marine Iron Works, located on the same pier.

Between Piers No. 1 and No. 2 a gridiron has been built for transferring cars or rolling stock from railroad tracks to barges. Landing floats with adjustable gangways and electrically operated truck boosters have been conveniently located at the end of slip 1 to aid in the delivery of materials from wagons to small boats, or from river barges to the dock level.

The award to the Foundation Company, New York, of contracts for the construction of Pier No. 3 and freight shed No. 4 marks another step in the develop-

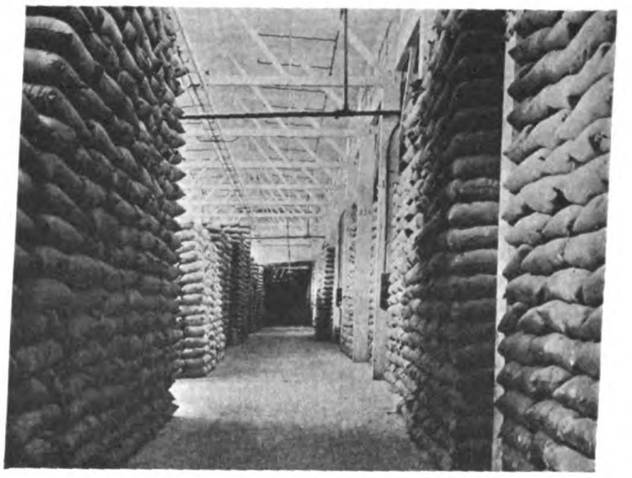
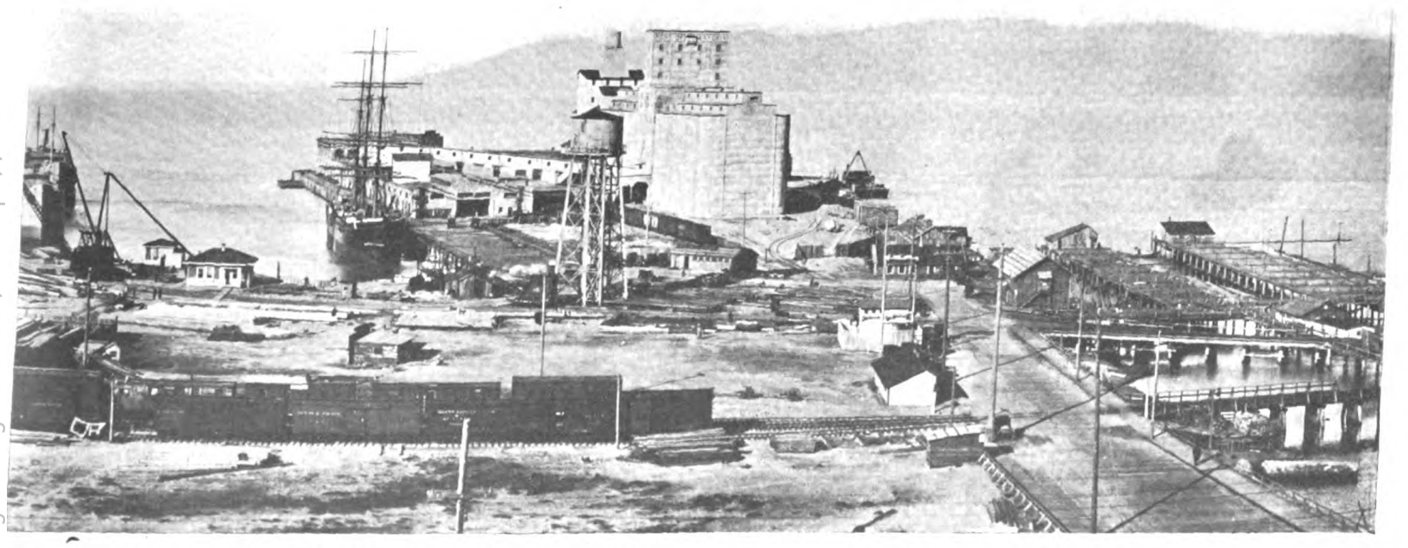


Fig. 6.—High Tiering in Pier Shed



Piers 1 and 2 in Operation. Wooden Shipyard Can Be Seen at the Left

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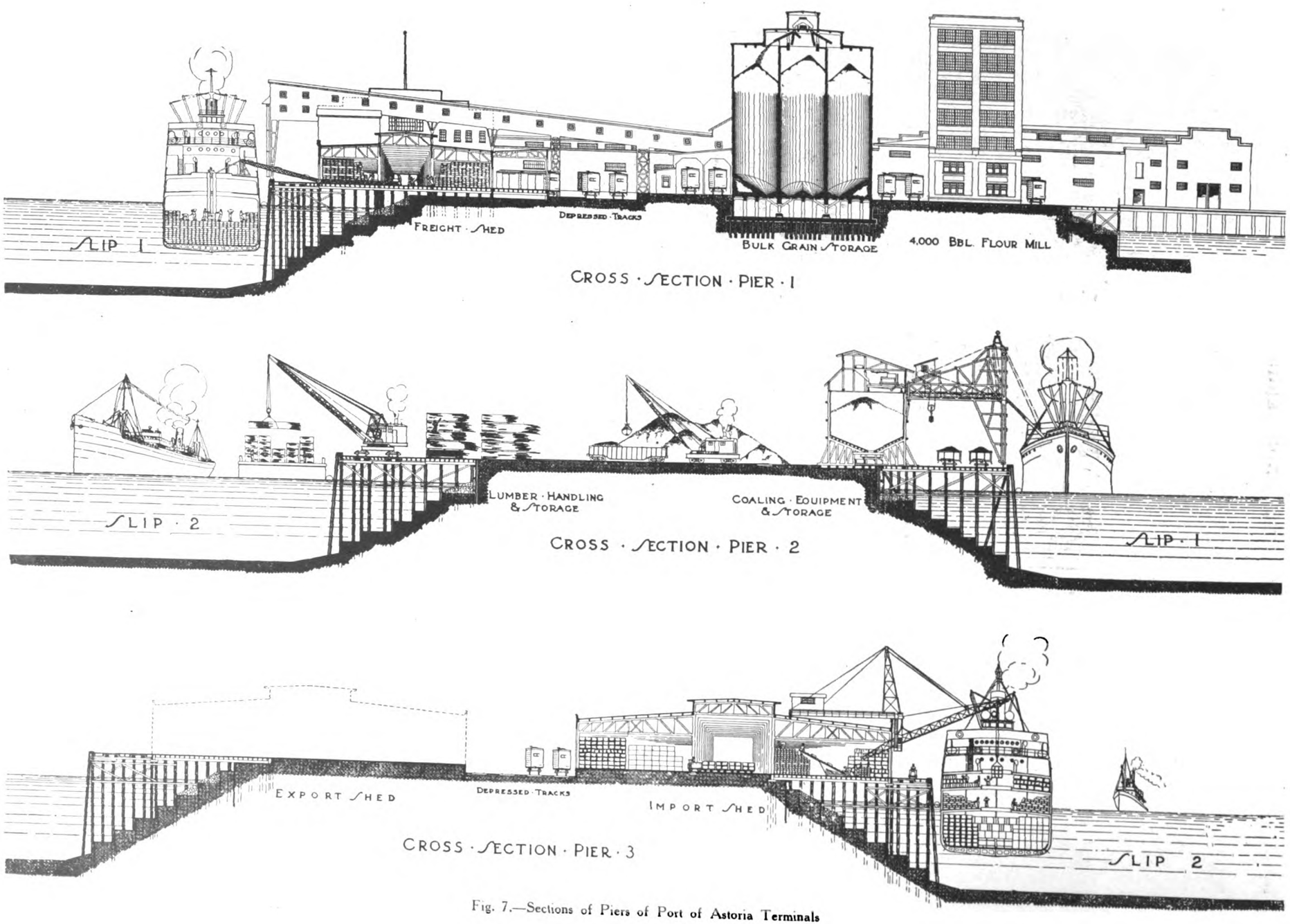

Fig. 7.—Sections of Piers of Port of Astoria Terminals

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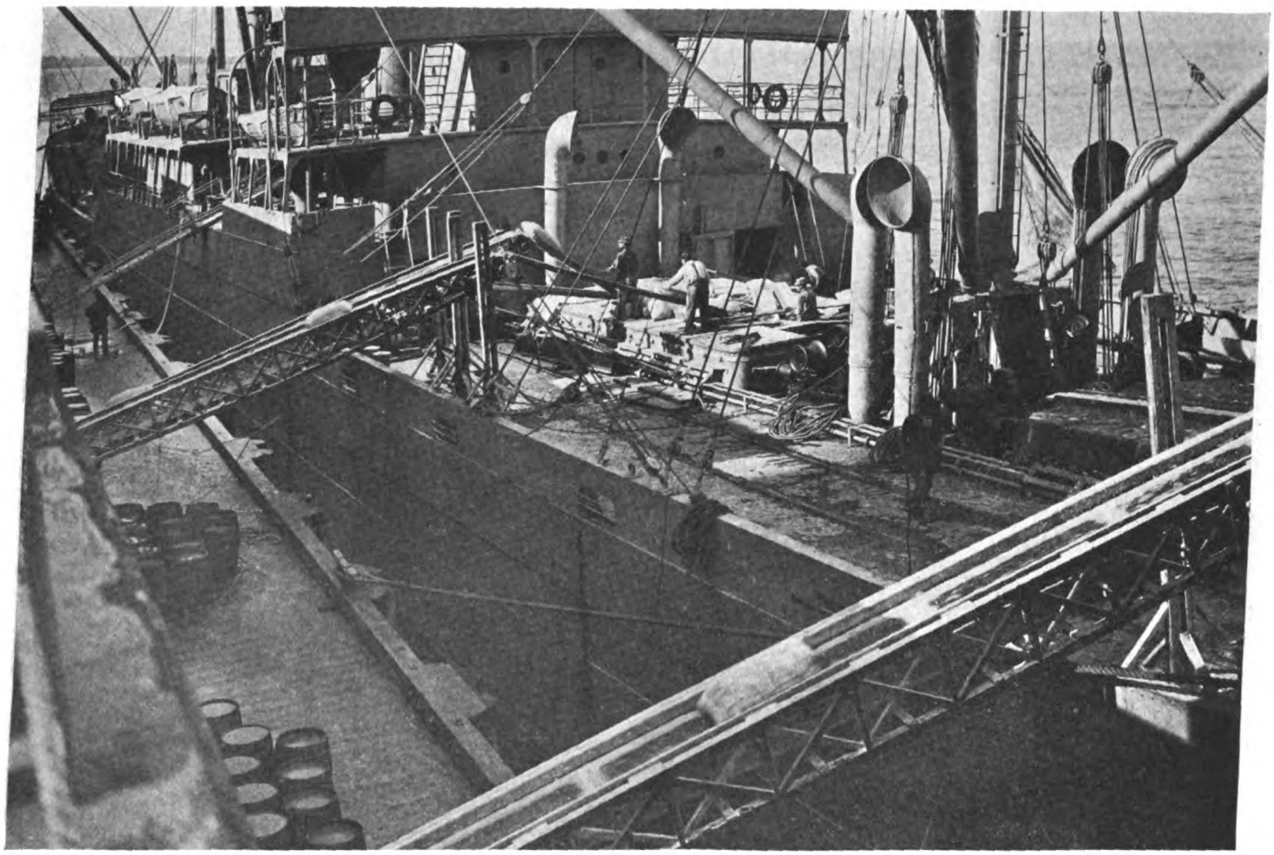

Fig. 8.—Mechanical Conveyors Assist in Loading and Discharging Vessels

ment of the far-sighted policy adopted by the Port of Astoria Commission. Preliminary estimates placed the cost of this work at about $800,000 (£164,000). This pier, upon which work has just been begun by the Foundation Company, will have a total frontage, as previously mentioned, of 3,875 feet.

The pier will be occupied by two sheds, one for import and the other for export freight. Only the import shed is included in the present contract. As may be noted from the accompanying cross-section, Pier No. 3 will consist of a solid fill surrounded by a wooden deck 74 feet wide, supported on piles. The interior fill is to be placed by the Port Commission, but the contractor is required to provide bulkheads between pile bents to retain the sluiced material. At the outer end of the pier the bulkheads reach a depth of 40 feet. The slope of the fill between bulkheads is to be riprapped, which will involve the placing of 11,000 cubic yards of stone.

The pile bents under the deck are on 10-foot centers, the piles being placed 6 feet apart. Caps, 14 inches by 14 inches, support 6-inch by 14-inch stringers, which carry the 4-inch deck plank. The latter is protected by a wearing surface of asphalt 1 inch thick. The entire pier will require about 5,200 piles between 40 and 100 feet long and about 4,000,000 feet board measure of lumber for framing, bracing and decking.

Pier Shed No. 4 will be about 1,600 feet long and 160 feet wide, with reinforced concrete walls, wooden posts and timber truss roof, used in the interior. The posts divide the interior space into three bays, the center bay having a width of 40 feet and the side bays 60 feet. The construction work will require the placing of 6,000 cubic yards of concrete and the framing of about 2,000,000 feet board measure of lumber. The contract calls for the completion of the work in one year, but the Foundation Company believes that it will be possible to turn over the pier to the Port Commission early in the summer of 1920.

The construction of this pier will be under the immediate supervision of W. A. Hanscom; M. T. Stack is the superintendent for the Foundation Company under the direction of Bayly Hipkins, vice-president, in charge of operations on the Pacific coast.

Upon three modern piers providing a berthing space of 11,714 feet, the Port of Astoria, Ore., plans to operate a large import shed, coal bunkers, a flour mill and a grain storage plant. The import shed now under construction is 1,600 feet long. Mechanical handling equipment now installed includes a 48-foot by 150-foot gridiron for loading locomotives and rolling stock, electrically operated truck boosters, eight portable conveyors, four electric portable piling machines, locomotive cranes, 39 electric motors, a traveling belt coal weightometer, two floor track automatic checkers, four manila catch-alls, 48 plank case slings and 16 chutes and sliding boards.

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European Motorship Developments

Largest Shipyards Vigorously Attacking Oil Engine Problems—Vickers System of Solid Injection—Electrically Welded Motorship

BY OUR SPECIAL LONDON CORRESPONDENT

PROBABLY one of the most interesting, and certainly one of the most significant features of the present development of marine oil engine construction in Europe is the fact that all the largest concerns are now devoting a great part of their enegry to this problem, and such world-renowned concerns as Vickers and Armstrongs are participating very actively in the new industry. In the majority of cases the leading marine engineering firms have converted their workshops, which during the war were employed for the manufacture of Diesel engines for submarines, to fabricate for the construction of low-speed mercantile oil engines, and arrangements in all cases are being made for rapid production on a standardized basis.

The work which is now being carried out by Vickers is of special interest. Two 10,000-ton motor oil tankers are being built by this firm for the Anglo-American Oil Company, and the first has already been launched, while the two engines are practically ready for installation in the new vessels. A brief description of these motors will be of interest, as they they represent a design embodying all the features which Vickers have found to be most satisfactory during their long experience with submarine engines, although they have, of course, specially adapted them for heavy, slow-running motors. Two engines are to be installed in each ship having six cylinders 24½ inches in diameter with a stroke of 39 inches, developing 1,250 brake horsepower, or about 1,600 indicated horsepower at 118 revolutions per minute. It may be added that this size of engine has been decided upon as being suitable for installation in the average type of cargo vessel of about 10,000 tons deadweight carrying capacity with a speed at sea of from 10 to 10½ knots.

Diesel Engines with Mechanical Injection

The most novel feature in the design from the point of view of the engineer accustomed to Diesel motors is that the well-known Vickers system of solid injection of fuel is employed, instead of providing a three-stage, high-pressure air compressor for blowing the fuel through the fuel valve nozzle, at a pressure of about 1,000 pounds per square inch. In these Vickers engines there are four fuel pumps driven in pairs by means of two eccentrics on a horizontal spindle which derives its motion from a vertical shaft. This shaft, which is driven from the crankshaft, drives at its upper end, through bevel gearing, the camshaft, on which are located all the cams for operating the inlet, exhaust, fuel and starting valves.

The fuel injection pumps, which are of the plunger type, operate at a pressure of about 4,000 to 4,500 pounds per square inch, and if it may appear that this high pressure is a source of danger it should be remarked that the same system has been employed on the large majority of British submarines and no accident has been recorded. In fact, the tendency is to increase the pressure still further, and in the solid injection system, which is used by Doxfords in their new type of Diesel engine, the pressure rises to as much as 7,000 or 7,500 pounds per square inch.

The valve gear is of a new type. In each cylinder cover is the fuel inlet valve in the center, together with an inlet and an exhaust valve on each side. These are all operated through valve levers from the cams on the horizontal camshaft mentioned above, and in order to provide for reversing, each valve has two cams side by side—one for ahead and one for astern running. On reversing when turning the reversing lever this actuates a Servo motor, which, by means of a lever, rotates the spindle upon which the valve levers are eccentrically mounted. The valve levers are thus lifted off the cams and the camshaft is then moved fore and aft by means of the reversing wheel. After this movement the valve levers are then brought down onto the cam once more, the main starting air valve is opened, admitting compressed air to the six cylinders. The next movement of the maneuvering wheel puts two of the cylinders on fuel and two on air, and finally the air is cut off and all the cylinders are put onto fuel.

In accordance with a design which is now becoming more common in British Diesel engine practice, the starting valves are not arranged in the cylinder cover itself, but below the camshaft operated by means of levers from cams on the shaft. From these valves pipes are taken direct to the cylinders, so by this means some simplification of the valve gear is effected. The exhaust valves are water-cooled and the pistons are cooled by lubricating oil, while the cylinders are, of course, cooled by means of sea water, a somewhat novel feature being the fact that the water enters at the top and goes downward, which, it is thought, will prevent any tendency for the cylinders to become choked up with mud.

Cammell-Laird's Novel Diesel Engine

The employment of electric welding on ships has attracted some interest in America, so that the new motor vessel which is now being completed by Cammell-Laird, and in which the whole of the work has been carried out by electric welding, will no doubt be closely watched in that country. The engine for this ship is the first of its type, but two further sets of the same design are being built to be installed in an Anchor Brocklebank cargo boat now under construction on the Clyde. This latter ship will be a vessel of about 8,000 tons, and the two motors are each of 900 horsepower (1,200 indicated horsepower), having four cylinders 18½ inches in diameter, with a combined stroke of 50 inches. The engine is built in two units of two cylinders each, and the opposed piston system is adopted, the top and bottom crossheads of adjacent cylinders being connected with diagonal rods. At the top of the cylinders the crosshead is formed into the piston of a scavenging pump, supplying scavenging air at a pressure of 1½ pounds per square inch, which is admitted to the bottom of the cylinder through ports in the periphery. The exhaust gases escape through ports at the top of the cylinder, so that there only remains the fuel valve actually in the cylinder itself. This is arranged horizontally in the center of the cylinder, the fuel being injected by compressed air just before the two pistons reach their point of nearest approach.

As in the case of the Vickers engine, the starting air valve is not in the cylinder, but is external to it with an air pipe leading to the cylinder, connection being made

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through a non-return valve. The fuel valves and also the external starting air valves are actuated by levers from cams on the camshaft, and when reversing this camshaft is rotated through a certain angle relative to the crankshaft, thus altering the timing of the fuel valves. This system is one of the simplest available and can be most satisfactorily employed in engines of the two-cycle type when there are only the fuel and starting air valves to be altered according to the direction of operation.

GERMAN MOTORSHIP FOR BRITISH OWNERS

Three interesting German motorships have recently been handed over to Great Britain in accordance with the peace terms. These are the Krupp-built *Loki*, the *Wotan* (built by the Reiherstieg Company) and the *Fritz*, constructed by Blohm and Voss. The latter, which has been acquired by the Glen Line is of unusual interest, in that two double-acting, two-cycle engines of 900 brake horsepower are installed. She is thus the only vessel in which double-acting motors are fitted. The engines have three cylinders with a bore and stroke of 18.9 inches and 26.4 inches respectively, running at 120 revolutions per minute. The scavenging pumps are fitted at the back of the engine and driven from the crosshead by rocking levers, and there are three fuel valves for each cylinder—two at the bottom and one at the top, the two at the bottom being necessary owing to the fact that the piston rod passes through the bottom cylinder cover.

Both the *Loki* and the *Wotan* are equipped with two-cycle motors, the latter being a single-screwed vessel with an 1,800-brake-horsepower engine and the former a twin-screw ship with two 1,250-brake-horsepower sets. In view of the fact, however, that the sister ship to the *Loki* (named the *Hagen*) proved a failure and the oil engines were replaced in America by steam engines, it is not thought that she will be found a particularly successful type of craft. It is, in fact, stated that Krupps have abandoned this design for four-cycle engines.

Operating a Large Marine Diesel Plant

BY E. N. PERCY

Many marine engineers, thoroughly at home in the engine room of a steam vessel, are beginning to show a lively interest in the operation of Diesel plants on motorships. In particular they wish to know how the work differs from steam engine work. In the first place, it may be said that any competent marine engineer, capable of operating a steam plant, can learn to take care of a Diesel plant by starting in as a second or third assistant and applying himself assiduously to mastering the details of the Diesel oil engine and its auxiliaries. On the other hand, to take a job as first assistant or chief engineer would be inviting trouble. Just what the conditions are is shown in the following article.

THERE is no mystery about Diesel engines, and an exposition of their working principles can be found in any good text-book on the subject. A good Diesel plant is a "home" and far less work to maintain than the average steam plant; in fact it can be maintained with almost no work in port. A poor or cheap Diesel plant, and particularly a semi-Diesel plant, requires much hard work to keep it in proper condition, particularly as such ships are often in the hands of owners who begrudge any outlay for maintenance.

High-grade engines are of the slow-speed, heavy type, equipped with the full, force-feed, circulating system of lubrication, and with all auxiliaries except the compressors driven separately from the engine. In very large engines even the compressors are separately driven.

TYPES OF ENGINES

Engines up to 500 horsepower are usually of the trunk piston type. Larger engines are of the crosshead type, built just like a marine steam engine, except that they are enclosed with light covers and flooded with circulating oil. Instead of water-cooled bearings, the oil is cooled in a separate cooler. The oil is also filtered. In the case of a crosshead engine, a bulkhead separates the crankcase from the cylinders and protects it from the dirty oil drippings of the cylinders. The pistons are water-cooled, as a rule, in engines above 500 horsepower.

The Diesel engine is a splendid and reliable servant to one who understands it, but with an unsympathetic operator it tends to act very much like a boiler in the hands of an ignorant water tender. There are things about both of them that can't be put in books—certain well-known signs—the "feel" of things, sounds, familiar vibrations, temperatures, oil sight feeds, pressure gages, etc. The Diesel engine speaks a much plainer language than a boiler and will tell one more; but— one must learn the language.

Starting up a Diesel plant is much like starting up a modern steam plant, except that it is not necessary to "warm up" anything. The Diesel engine will, after proper inspection, start right "off the bat" after a month's or a year's stop and carry full load within thirty seconds.

AUXILIARIES STARTED FIRST

The engineer on watch will first have an auxiliary engine running, so as to have electricity. Practically all large Diesel ships now have electric auxiliaries. If the ship is "dead"—that is to say, has no engines running and no air on hand to start them—the "emergency" compressor is started. This is a small compressor coupled to a small steam engine on the donkey boiler, or a small gas engine, or a small semi-Diesel engine which can be started by hand. This compressor is then operated until enough air is in one of the smaller bottles to supply injection and starting air for one of the large auxiliary engines. Every Diesel ship has from two to four auxiliary electric generating sets ranging from 50 to 200 horsepower, according to the size and type of ship.

When the larger engine can be started the auxiliary electric compressor is then started. Sometimes this compressor is direct-coupled to one of the auxiliary engines instead of a dynamo. Sometimes both are coupled to one engine with clutches.

The auxiliary compressor is then operated until the maneuvering air tanks are fully charged—usually to about

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350 pounds per square inch. Then the injection air bottles on the main engines, the reserve injection air bottles and the bottles on the auxiliary engines are charged. These various bottles are carefully shut off after charging, except those about to be used in starting the plant.

After the bottles are all charged and a good supply of air is on hand and the electric plant is running in good shape, the fuel transfer pump is started and the day tanks filled with oil from the main storage. This gives the oil a chance to settle. There should be at least one day tank which had been previously filled and allowed to settle for some hours. Any water in the bottom should be drained into a bilge pump. This tank may then be connected to the main engine and auxiliary engine fuel pumps. The hand pump on the main engine is then used to fill the fuel system of the main engine with oil until the try cocks at each injection valve show oil.

The circulating water pump should be started before the main engine is moved for any purpose whatever. The same may be said of the circulating pump for lubricating oil.

The electric bilge, sanitary and fire pumps are used the same as in a steamship. The maneuvering and injection air may then be turned on the engines.

Handling the Throttle

The modern large Diesel has either a handwheel for reversing or an air-ram with oil cylinder. The "throttle" is a rather complicated affair, although very simple to operate. It consists, as a rule, of two levers, one for each half of the engine. When these levers are pulled one way they are air throttles and start the engine just like a steam engine. When shoved the other way they are oil throttles and start the engine off as a Diesel. These throttles also operate the air-starting valves and throw them out of gear when no longer needed. They also operate the relief valves to prevent a cylinder from hanging up against the high compression. The throttles shut off the oil and injection air until swung over to the oil side. They also operate on the governor to regulate the speed of the engine.

The operator must, of course, learn to maintain and adjust all these parts, but they are not nearly as complicated as the condensing and feed water system which the average steam engineer knows so well.

After the maneuvering air is turned on, the reverse may be tried out and the engine turned over a few times forward and back to make sure that all is clear and that she "takes" the oil. At first the operator may be a little timid, but as he becomes familiar with the engine and learns to connect cause and result, and knows the few things that interfere with the proper operation of the engine, he comes to have great confidence, because he knows that no matter what happens he will understand it and quickly remedy the trouble.

Starting the Engine

A Diesel engine starts very suddenly compared to a steam engine, and almost instantly gets into its stride. It is customary to start the whole engine on air, then swing half the engine to oil. If it "takes," the other half is swung over also. If it does not "take" and the bridge has transmitted an order, it is pulled back to "air" and the other side tried on oil. An engine that may hesitate slightly on starting will usually go off fine when dragged a couple of turns by the other half. The relief valves usually spit when a Diesel starts; so, all told, it does not appear so smooth and easy as a steam engine, but one soon becomes accustomed to the peppery ways of a Diesel and acquires a liking for its willingness to be up and doing.

If considerable maneuvering is expected the auxiliary compressor is started. One need not feel nervous about keeping it running or shutting it down, as on a modern well-designed plant the air pressures rise and fall very slowly and there is plenty of time for everything, even if bells come in fast for a couple of hours, as in a difficult piece of docking.

Adjustments Easily Accomplished

While a Diesel looks complicated, the adjustment of each part is easily accomplished if studied and will produce a definite effect quickly learned. For instance, too high an injection air pressure will cause a cylinder knock because the fuel is all blown in at once instead of being fed in across the top of the indicator diagram. This is regulated, as a rule, by a suction gate valve on the compressor. A sticking injection valve causes one kind of trouble, and a burned exhaust valve another, or a leaky piston ring still another—all are easily recognized and remedied.

During a trip it is customary to overhaul all auxiliary machinery, spare valves and spare parts. In port the main bearings and pins are gone over, and spare valves exchanged for burned or dirty valves.

During a trip kerosene (paraffin) is used freely to clean valve stems and guides. Pure kerosene (paraffin) is fed to the engine for a few minutes each day to clear the delicate injection valve of tar or carbon.

A filtering system is usually provided for the lubricating oil. The system includes cooling coils and settling tanks. The cylinders are usually lubricated separately with pump drips. A special, fine adjustment is provided for each stage of the air compressor. It is important that none of the air compressors has an excess of lubricating oil. In the first place it is liable to explode in the compressor and wreck the compressor, although recent designs are made to stand this stress. In the second place, oil drippings or oil mist may accumulate in the air receivers and make an explosion possible. Certain electrical or chemical actions not fully understood cause combustion under these conditions, with serious results.

Drains Must Be Watched

It is important to inspect and drain water from day tanks, water and oil from maneuvering air tanks, injection air tanks, receivers and intercoolers on each stage of all air compressors, and oil filter tanks. These should be drained systematically and entered in the log.

When a Diesel engine, either main or auxiliary, is stopped, the circulating pump should be kept running until the heads are quite cool; otherwise hot water and steam will collect in the heads, baking the salt on the jacket side and baking the lubricating oil on the other side. Furthermore, if the heads happen to dry out and become hot and then the pump is again started, the cold water is quite apt to crack the heads.

Thermometers or pyrometers are usually provided in the exhaust pipes, principally to show if one engine is running hotter than others. If so, it is considered a pretty good sign that that engine is doing more than the others, and a slight adjustment is made on the oil.

It is extremely important to keep water out of the lubricating oil. Non-saponifying oils are used for the cylinders, and it is considered good practice to use the same oil in the circulating system, and thus carry only one stock of oil.

It has not been intended in this article to instruct in the operation of the Diesel, for that cannot be done in writing.

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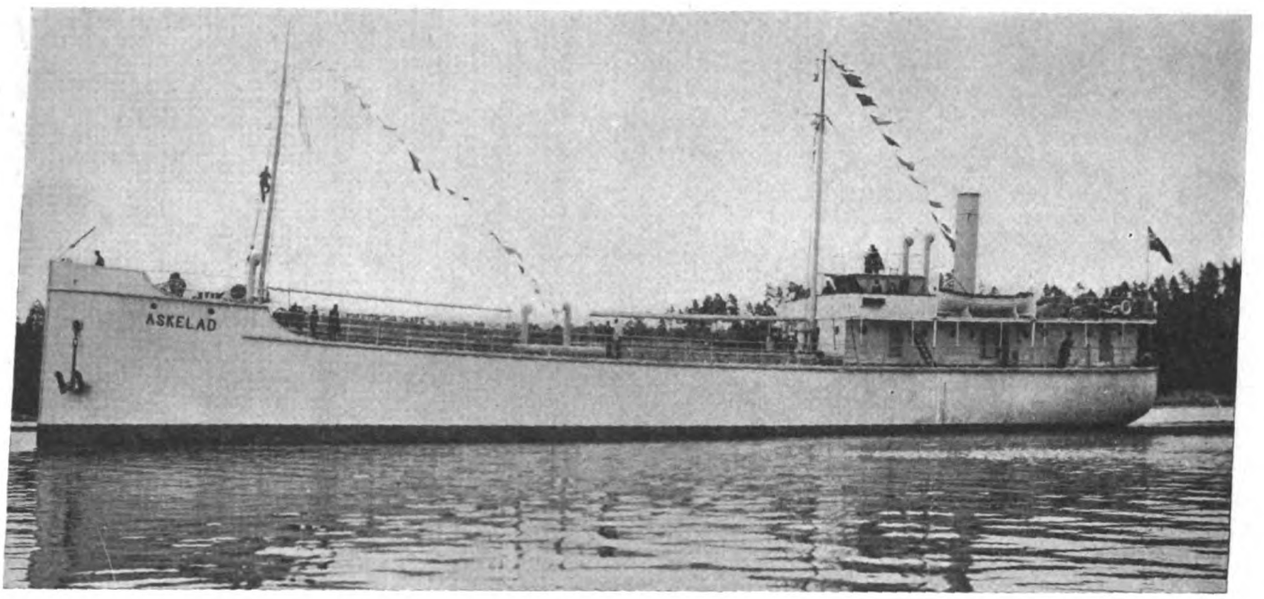

Reinforced Concrete Cargo Vessel Driven by Hot Bulb Crude Oil Engines

but merely to draw a little picture of operating conditions for the benefit of steam engineers. Diesel operation should not be judged by a few miserable, underpowered sailing ships equipped with cheap engines or with the experiments of various inventors. This article refers to the one hundred or more ships with years of successful operation to their credit, and equipped with upwards of two thousand horsepower each. Such ships, we regret to say, fly foreign flags exclusively. We are, however, entering slowly upon an era of motorships, but it is against much protest in high places.

All other countries are committed to huge motorship programmes, in spite of the fact that we are the producers of one-third of the world's supply of petroleum. The Diesel engine will eventually supplant other forms of marine propulsion because it has behind it natural laws which cannot be gainsaid by propaganda, prejudice or inertia. Successful engines are now available, and there is no record of failure or displacement of modern, conservative, slow-speed, well-known Diesel engines.

It is not the saving in cost of fuel where the Diesels primarily win out, although they use one-third the fuel of a steam engine of triple-expansion type, but in the fact that ships equipped with this system of propulsion carry from ten to thirty percent more freight with half the crew and less insurance.

A Successful Motor-Driven Concrete Tramp

ONE of the essential factors in the war against prevailing high prices must be the reduction of freight rates. This calls for cheaper boats and cheaper motive power.

In regard to cheaper vessels, the reinforced concrete construction may be considered a success and past the experimental stage. The same may be said relative to cheaper power as represented by some well-known hot bulb crude oil engines. A combination of these two would, therefore, mean a considerable advance in the desired direction.

Following is an abstract from the log book of the Norwegian-built concrete ship *Askelad* (170 feet by 31 feet, of 1,000 tons deadweight). This boat is equipped with two 2-cylinder Bolinder crude oil engines, each of 160 horsepower. The abstract of the log needs no comment and serves to show the good features of the boat, as well as the precision, reliability and low running cost of the engine:

"Left Kristiania December 11, 1918. Arrived Rouen December 23, 1918. Total running time of engine 182 hours. The ship was at anchor several nights because of the danger of mines. The port engine stopped twice, each time five minutes, to change air valve springs. Starboard engine stopped once for the same reason. Kerosene (due to the fact that no other oil was obtainable in Norway) was used and the consumption was 154 pounds per hour. The lubricating oil consumption was 6½ pounds per hour. The average speed of the engines was 220 revolutions per minute.

"Left Rouen January 6, 1919, in ballast. Arrived London February 7, 1919. Total running time of engines 60 hours. The ship laid in Havre ten days, went on shore and remained for sixteen days, but was taken off by own power. The engines were running perfectly.

"Left London March 7, 1919. Arrived Grimsby March 9, 1919. The running time of engine 32 hours without any stop. The kerosene consumption was 132 pounds per hour. Lubricating oil consumption 6 pounds per hour. The average speed of engines 225 revolutions per minute.

"The ship left Grimsby after repairing damages due to the stranding on March 9, 1919, but the sea was too rough and they had to let go the anchors. When one anchor chain broke the engines were started in case of emergency and were running for forty hours.

"Left Grimsby April 1, 1919, and arrived at Shields April 2, 1919. Total running time of engines was 20 hours without any stop. Crude oil consumption was 132 pounds per hour. Crude oil was now used for fuel. The lubricating oil consumption was six pounds per hour. The average speed of engines 225 revolutions per minute.

"Left Shields April 4, 1919. Arrived Calais April 7, 1919. The running time of engines was 48 hours without any stop. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 6 pounds per hour. The average speed of the engines 220 revolutions per minute.

"Left Calais April 12, 1919. Arrived Kings Lynn April 17, 1919, via Yarmouth. Actual running time of engine 31 hours without any stop. Crude oil consumption 132 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. The average speed of engine 225 revolutions per minute.

"Left Kings Lynn April 27, 1919. Arrived Rotterdam April 30, 1919. Actual running time 60 hours without any stop.

"Left Rotterdam May 5, 1919. Arrived Shields May 7, 1919. Actual running time of engines 39 hours without any stop. Crude oil consumption 132 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 225 revolutions per minute.

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"Left Shields May 10, 1919. Arrived Kristiansand May 12, 1919. Continued the trip to Fredriskshald May 13, 1919. Arrived May 15, 1919. Actual running time of engines 79 hours without any stop. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute.

"Left Fredrikshald May 19, 1919, in ballast. Arrived Drammen the same day. Actual running time of engine 9 hours without any stop.

"Left Drammen May 24, 1919. Arrived London May 29, 1919. Actual running time of engine 125 hours without any stop. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute.

"Left London June 6, 1919. Arrived Methill June 8, 1919. Actual running time of engines 53 hours without stop. Crude oil consumption 132 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 225 revolutions per minute.

"Left Methill June 20, 1919. Arrived Fredrikshaven June 23, 1919. Actual running time of engines 74 hours. Starboard engine stopped once for changing of air valve springs; could be started without reheating. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 220 revolutions per minute.

"Left Fredrikshaven June 27, 1919, in ballast. Arrived Gothenburg the same day. Actual running time of engine 7 hours. Crude oil consumption 132 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 225 revolutions per minute.

"Left Gothenburg July 9, 1919, for London. Actual running time of engines 155 hours without any stop. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute.

"Left London July 24, 1919, in ballast. Arrived Methill July 27, 1919. Actual running time of engines 171 hours. Port engine stopped twice because of air in fuel suction line. Starboard engine stopped once for changing air valve springs. At each stop the engines could be restarted without reheating. Crude oil consumption 132-143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 200 to 225 revolutions per minute.

"The reason for the speed difference was a high sea and head wind.

"Left Methill July 30, 1919. Arrived Kristiania August 4, 1919, via Kristiansand. Actual running time of engines 93 hours. The starboard engine stopped once for exchange of two air valve springs. Port engine stopped once for cleaning the injection nozzle. In each occasion the engines could be restarted without reheating. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute."

Summary of Engineers' Log Book Covering the First Eight Months' Operation

The starboard engine was stopped four times for replacing air valve springs.

The port engine was stopped twice for replacing air valve springs and twice for air in the suction line and once for cleaning out a fuel injection nozzle.

In each case, however, the repairs did not take more time than that the engine could be started again without reheating the hot bulb, i. e., a few minutes.

Total running time, 1,238 hours.

Average fuel consumption, 137.5 pounds per hour for the eight months of operation.

Total price of fuel oil for 1,238 hours, if bought in this country, $1,111.59 on a basis of 45 cents per gallon.

The fuel bill for a steam engine would, during the same period, have been $2,475, estimated on the basis of 2.5 pounds of coal per brake horsepower per hour.

The cost for repair parts during the eight months was $2.70, namely, six air valve springs at 45 cents each.

Early Transatlantic Steamers

BY F. B. C. BRADLEE

THE recent celebration of the centenary of transatlantic steam navigation calls to mind two very early steamers that crossed the Atlantic and which seem to have been overlooked, or forgotten, by the historians.

The first of these was the *Beaver,* a small craft owned by the Hudson's Bay Company; she was built of wood in 1835 by Green and Sons, London, measuring 187 tons gross, 101 feet long and 20 feet beam; her machinery (probably of the side-lever type) is quoted as of "70 nominal horsepower."

The *Beaver* was sent out from England to British Columbia in 1835, it is said, under her own steam. If, as there seems to be no doubt, this is so, why is not this little steamer the pioneer to cross *from Europe* instead of the *Great Western* and *Sirius,* whose first voyages were not made until 1838?

The *Beaver* was also the first steamer in the Pacific Coast, where she remained in active service until 1888, when she was wrecked near Vancouver, B. C.

Another early transatlantic steamer was the *City of Kingston.* She also was built at London in 1837 and was intended for a packet between Jamaica and Carthagena. She left London for her destination, calling at Madeira, early in 1838—certainly before the *Sirius* and *Great Western* made their voyages.

On the run from Plymouth to Madeira she was seven days, five of which were under steam. Failing to find the expected business as a packet, the *City of Kingston* left Jamaica about the middle of March for New York, but was obliged to put in at Norfolk, Va.

Here she remained several days and then started again, but on March 31 she met with a gale and was unable to make steam with either anthracite coal or wood, so put back and went to Baltimore.

She left Baltimore on May 27, 1838, for London direct, commanded by Captain Crane and having 300 tons of coal on board, which was sufficient for her to steam all the way on the passage across. As some authors have gone so far as to say that the *City of Kingston* was a myth, the following quotations from the *New York Shipping and Commercial List* will definitely clear the matter up: "March 17, 1837, under Norfolk, Va., arrivals: 'Br. steamer *City of Kingston,* Gibbs, Kingston, Jamaica.'" "May 23, 1838, under Baltimore, Md., cleared: 'Br. steamer *City of Kingston,* Crane, London.'"

Fig. 1.—The *Beaver,* First Steamer on the Pacific; wrecked at Vancouver, B. C., 1888

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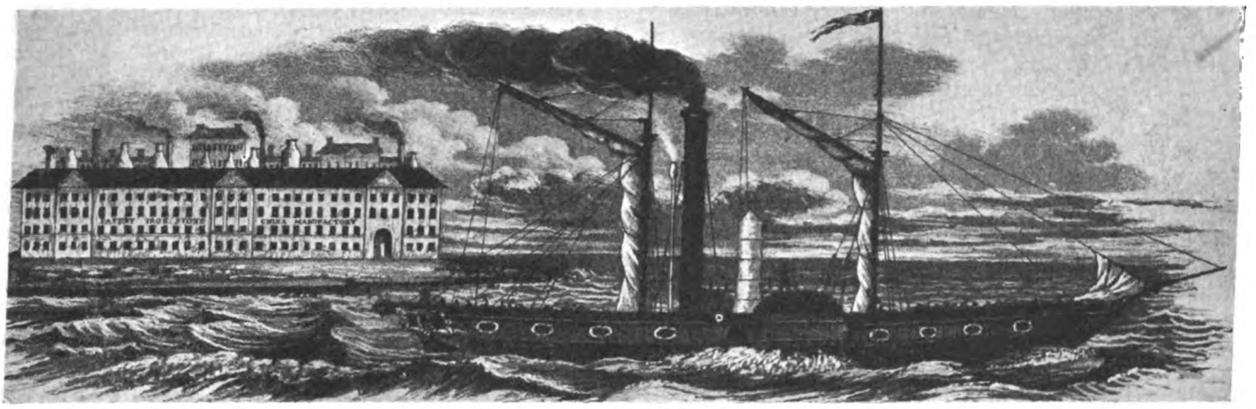

Fig. 2.—The *City of Kingston* (that crossed the Atlantic in 1838) in Her Later Days as a Cross-Channel Packet

The *City of Kingston* measured 325 tons. She was schooner-rigged and, besides, carried a large square sail on the foremast. Her construction is described as "long and buoyant."

The machinery consisted of two low-pressure engines (probably of the side-lever type), each of 50 nominal horsepower. The cylinders were 40 inches in diameter, with 4 feet 4 inches stroke. There were two boilers, consuming one-half ton of coal every hour.

It is believed the *City of Kingston* finished her days in the cross-channel service between Southampton and Havre.

New Method of Joining Ship Sections

BY JAMES NACY*

WHEN it became necessary to utilize the shipyards along the shores of the Great Lakes for building ocean-going vessels of great tonnage, various methods of sectional construction were developed to permit the passage of the ships through the canal locks on their way to the Atlantic. One such method has been designed with the object of eliminating the use of a dry dock in assembling the several sections.

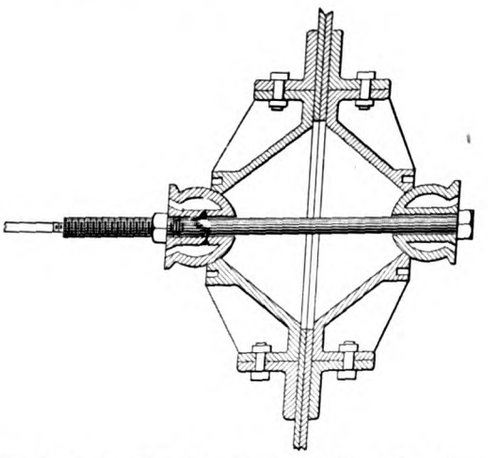

Fig. 1.—Ball and Socket Bolts to Facilitate the Alinement of Ship Sections Being Joined

The idea is to render each section a seaworthy unit by closing the ends with special watertight bulkheads and to arrange pipe connections in each section so that the usual trouble of pipe fitting after assembly is avoided. A vessel may be launched in sections and assembled after passing through the locks, or it may be launched as a unit and disassembled when necessary.

Features of the Construction

The method of construction is essentially to provide each section of the ship with an athwartship bulkhead, forming a vertical end wall, smooth on the outer side. On the inboard side this bulkhead is connected with the decks and braced so that the section may be navigated successfully. When separated, bolt and rivet holes in the bulkheads are closed.

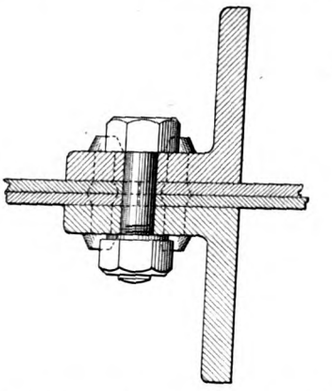

Fig. 2.—Method of Bolting Bulkhead Stiffeners

In joining the parts of the ship a heavy canvas jacket is carried around the connection and strapped to the rails on either side to prevent water interfering with the work. When the sections are first abutted a row of bolts or rivets along the waterline is fastened through the bulkheads; then if not in proper alinement the trim of the sections may be obtained to make correct adjustment possible. Bolts and rivets are then fitted across the deck angle and down each side to the center keelson.

May Be Applied to Regular Hull Design

The hardest operation is to bring the sections in accurate alinement, and for this purpose long bolts, having ball and socket seats, are fitted through the bulkheads. The pads for the sockets have a decided flare, so that the bolts are permitted to pass through at quite an angle. Spherical collars insure the proper heading of the bolts. When the bolts and collars are in place the nuts are turned up so that the sections are accurately drawn together.

No special hull design other than the bulkheads at the

* Marine architect, surveyor, etc., Milwaukee, Wis.

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"Left Shields May 10, 1919. Arrived Kristiansand May 12, 1919. Continued the trip to Fredriskshald May 13, 1919. Arrived May 15, 1919. Actual running time of engines 79 hours without any stop. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute.

"Left Fredrikshald May 19, 1919, in ballast. Arrived Drammen the same day. Actual running time of engine 9 hours without any stop.

"Left Drammen May 24, 1919. Arrived London May 29, 1919. Actual running time of engine 125 hours without any stop. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute.

"Left London June 6, 1919. Arrived Methill June 8, 1919. Actual running time of engines 53 hours without stop. Crude oil consumption 132 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 225 revolutions per minute.

"Left Methill June 20, 1919. Arrived Fredrikshaven June 23, 1919. Actual running time of engines 74 hours. Starboard engine stopped once for changing of air valve springs; could be started without reheating. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 220 revolutions per minute.

"Left Fredrikshaven June 27, 1919, in ballast. Arrived Gothenburg the same day. Actual running time of engine 7 hours. Crude oil consumption 132 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 225 revolutions per minute.

"Left Gothenburg July 9, 1919, for London. Actual running time of engines 155 hours without any stop. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute.

"Left London July 24, 1919, in ballast. Arrived Methill July 27, 1919. Actual running time of engines 171 hours. Port engine stopped twice because of air in fuel suction line. Starboard engine stopped once for changing air valve springs. At each stop the engines could be restarted without reheating. Crude oil consumption 132-143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engines 200 to 225 revolutions per minute.

"The reason for the speed difference was a high sea and head wind.

"Left Methill July 30, 1919. Arrived Kristiania August 4, 1919, via Kristiansand. Actual running time of engines 93 hours. The starboard engine stopped once for exchange of two air valve springs. Port engine stopped once for cleaning the injection nozzle. In each occasion the engines could be restarted without reheating. Crude oil consumption 143 pounds per hour. Lubricating oil consumption 5.5 pounds per hour. Average speed of engine 220 revolutions per minute."

SUMMARY OF ENGINEERS' LOG BOOK COVERING THE FIRST EIGHT MONTHS' OPERATION

The starboard engine was stopped four times for replacing air valve springs.

The port engine was stopped twice for replacing air valve springs and twice for air in the suction line and once for cleaning out a fuel injection nozzle.

In each case, however, the repairs did not take more time than that the engine could be started again without reheating the hot bulb, i. e., a few minutes.

Total running time, 1,238 hours.

Average fuel consumption, 137.5 pounds per hour for the eight months of operation.

Total price of fuel oil for 1,238 hours, if bought in this country, $1,111.59 on a basis of 45 cents per gallon.

The fuel bill for a steam engine would, during the same period, have been $2,475, estimated on the basis of 2.5 pounds of coal per brake horsepower per hour.

The cost for repair parts during the eight months was $2.70, namely, six air valve springs at 45 cents each.

Early Transatlantic Steamers

BY F. B. C. BRADLEE

THE recent celebration of the centenary of transatlantic steam navigation calls to mind two very early steamers that crossed the Atlantic and which seem to have been overlooked, or forgotten, by the historians.

The first of these was the *Beaver,* a small craft owned by the Hudson's Bay Company; she was built of wood in 1835 by Green and Sons, London, measuring 187 tons gross, 101 feet long and 20 feet beam; her machinery (probably of the side-lever type) is quoted as of "70 nominal horsepower."

The *Beaver* was sent out from England to British Columbia in 1835, it is said, under her own steam. If, as there seems to be no doubt, this is so, why is not this little steamer the pioneer to cross *from Europe* instead of the *Great Western* and *Sirius,* whose first voyages were not made until 1838?

The *Beaver* was also the first steamer in the Pacific Coast, where she remained in active service until 1888, when she was wrecked near Vancouver, B. C.

Another early transatlantic steamer was the *City of Kingston.* She also was built at London in 1837 and was intended for a packet between Jamaica and Carthagena. She left London for her destination, calling at Madeira, early in 1838—certainly before the *Sirius* and *Great Western* made their voyages.

On the run from Plymouth to Madeira she was seven days, five of which were under steam. Failing to find the expected business as a packet, the *City of Kingston* left Jamaica about the middle of March for New York, but was obliged to put in at Norfolk, Va.

Here she remained several days and then started again, but on March 31 she met with a gale and was unable to make steam with either anthracite coal or wood, so put back and went to Baltimore.

She left Baltimore on May 27, 1838, for London direct, commanded by Captain Crane and having 300 tons of coal on board, which was sufficient for her to steam all the way on the passage across. As some authors have gone so far as to say that the *City of Kingston* was a myth, the following quotations from the *New York Shipping and Commercial List* will definitely clear the matter up: "March 17, 1837, under Norfolk, Va., arrivals: 'Br. steamer *City of Kingston,* Gibbs, Kingston, Jamaica.'" "May 23, 1838, under Baltimore, Md., cleared: 'Br. steamer *City of Kingston,* Crane, London.'"

Fig. 1.—The *Beaver,* First Steamer on the Pacific; wrecked at Vancouver, B. C., 1888

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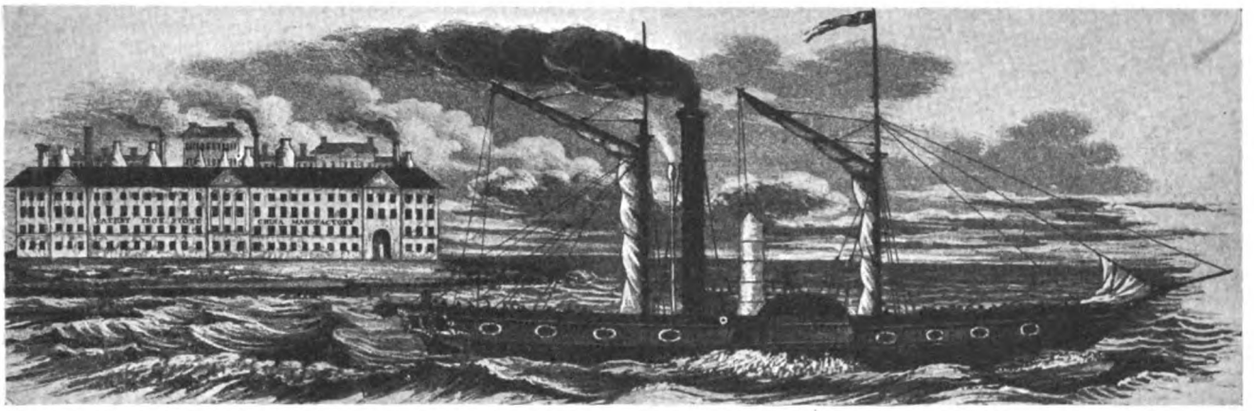

Fig. 2.—The *City of Kingston* (that crossed the Atlantic in 1838) in Her Later Days as a Cross-Channel Packet

The *City of Kingston* measured 325 tons. She was schooner-rigged and, besides, carried a large square sail on the foremast. Her construction is described as "long and buoyant."

The machinery consisted of two low-pressure engines (probably of the side-lever type), each of 50 nominal horsepower. The cylinders were 40 inches in diameter, with 4 feet 4 inches stroke. There were two boilers, consuming one-half ton of coal every hour.

It is believed the *City of Kingston* finished her days in the cross-channel service between Southampton and Havre.

New Method of Joining Ship Sections

BY JAMES NACY*

WHEN it became necessary to utilize the shipyards along the shores of the Great Lakes for building ocean-going vessels of great tonnage, various methods of sectional construction were developed to permit the passage of the ships through the canal locks on their way to the Atlantic. One such method has been designed with the object of eliminating the use of a dry dock in assembling the several sections.

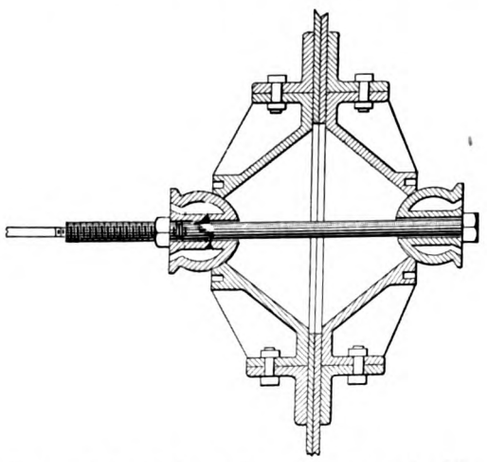

Fig. 1.—Ball and Socket Bolts to Facilitate the Alinement of Ship Sections Being Joined

The idea is to render each section a seaworthy unit by closing the ends with special watertight bulkheads and to arrange pipe connections in each section so that the usual trouble of pipe fitting after assembly is avoided. A vessel may be launched in sections and assembled after passing through the locks, or it may be launched as a unit and disassembled when necessary.

Features of the Construction

The method of construction is essentially to provide each section of the ship with an athwartship bulkhead, forming a vertical end wall, smooth on the outer side. On the inboard side this bulkhead is connected with the decks and braced so that the section may be navigated successfully. When separated, bolt and rivet holes in the bulkheads are closed.

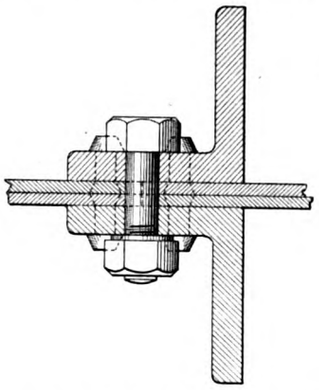

Fig. 2.—Method of Bolting Bulkhead Stiffeners

In joining the parts of the ship a heavy canvas jacket is carried around the connection and strapped to the rails on either side to prevent water interfering with the work. When the sections are first abutted a row of bolts or rivets along the waterline is fastened through the bulkheads; then if not in proper alinement the trim of the sections may be obtained to make correct adjustment possible. Bolts and rivets are then fitted across the deck angle and down each side to the center keelson.

May Be Applied to Regular Hull Design

The hardest operation is to bring the sections in accurate alinement, and for this purpose long bolts, having ball and socket seats, are fitted through the bulkheads. The pads for the sockets have a decided flare, so that the bolts are permitted to pass through at quite an angle. Spherical collars insure the proper heading of the bolts. When the bolts and collars are in place the nuts are turned up so that the sections are accurately drawn together.

No special hull design other than the bulkheads at the

* Marine architect, surveyor, etc., Milwaukee, Wis.

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end of the sections is necessary. Bulkhead plates are strengthened by triangular braces riveted to the upper or under side of the deck, as the case may be. Riveted angle bars complete the fastening of these braces to the deck. Vertical stiffeners are provided not only at the abutting edges of the adjacent bulkhead plates, but also at the vertical center of these plates. The method of bolting stiffeners through the bulkhead is indicated in Fig. 2. Between the shell bottom and tank top the structure is braced and the plate closed by a construction similar to that above the tank top. Girders are provided which extend intermedially fore and aft to brace the bottom structure. Between decks short stringers are placed to stiffen the bulkheads and shell at this place. Adjacent to the bulkheads the plates are provided with doublers and angles at the inner edge. Stringers are also connected to the bulkheads by vertical triangular bracing plates.

Every effort has been made to render the transverse end bulkhead thoroughly capable of withstanding moderately heavy weather while proceeding in sections. After the sections are bolted, a heavy angular bosom strap is placed over the end portions of the gunwale angle and extended a sufficient distance each side of the junction to allow a number of bolts to be secured. The upright flange of this strap is also firmly bolted to the sheer strake and sheer doubler. To reduce the amount of fastening to the bulkheads, outside doublers for the deck or shell may be added after the sections are bolted.

The bulkheads are designed to form a permanent part of the vessel and can be made more secure than is ordinarily the case when sections of a ship are joined. They also serve as transverse stiffeners when the vessel is completed.

The invention may be utilized or adapted to ships already built, for the bulkheads may be installed and stiffened as proposed above.

Notes on Connecting Rods

BY JOHN BRENT

When I began my trade a Scotchman put me wise to the value of keeping notes on what I did and what I saw. For a long time I found that after making notes it was a very troublesome matter to find the notes again. At last I was shown that by the use of filing cards I could index my notes.

I used these cards for taking down anything of interest, making but one entry on each card unless I had two things to jot down on the same subject, then I made two notes on the same card. I transferred these index cards to a loose-leaf book, placing them under the letter of the index to which they belonged, but at times it was difficult to know just what heading was best.

Under the heading "Connecting Rods" I found the other day a few items which I think might interest the readers of MARINE ENGINEERING.

In an Austrian ship I saw a forked end connecting rod fitted with an adjustment for each of the crosshead pin bearings, and that was something new to me.

The top end of the rod was finished in the usual way, but the lower half of the brasses were finished quite differently. Instead of the brasses finishing flush with the tops they overhung about one-quarter of an inch. The lower face of the brass was cut out so that the overhang came down over the rod and was not straight between these edges but tapered. Between the brasses and into this recess a steel wedge was fitted through which the bolts passed, but the holes in the wedge were elongated athwartship. This allowed for adjustment of the wedge.

The amount of possible adjustment was small—not over three thirty-seconds of an inch—but it is clear that by this construction either side of the connecting rod brasses could be very nicely brought to a bearing.

On the lower end of the rod on an Italian ship I saw this construction: The top half of the crank pin brass and the lower end of the rod were hinged athwartship, so that the brass was "flexible," so to speak. The design was not as clumsy as one might think, and I was told by the engineer in charge that until the hinged system was put on the crank pin brasses gave great trouble by heating.

Over on the French coast I saw a torpedo boat built by Normand, and the lower end of the connecting rods on this boat made me stare. Standing in front of the engine the lower ends of the rods were thinned down, just above the foot to about half an inch in thickness for 4 inches up. Looking at the rods from the inboard end of the engine the thinned portions of the rods were bulged out athwartship so that they looked like the ace of hearts.

The amount of metal in these bulged parts was just equal to the amount of metal that would have been in the rods if they had not been thinned down. The idea was to allow a little spring in the rods for self-adjustment of the brasses, and I was told that they worked very well.

Down below Atlantic City I saw two or three little steam launches fitted with compound engines and the thrust bearings in these boats were unusual. Instead of the horseshoe collar fitted between collars turned on the shaft having parallel faces, the shaft collars were turned with faces set at a slight angle to the center of the shaft, making a cross-section very much like an Acme thread. Instead of one horseshoe for each collar, two were fitted, the top one being drilled free for bolts that entered tapped holes in the lower horseshoes. This allowed the two halves to be drawn together so as to fit the shaft collars nicely, with the result that about twice as much bearing surface was obtained and the adjustment for wear was made very easy. The two horseshoes extended out from the shaft and fitted into slots in the thrust bearing block. This bearing was covered with a plate, keeping out dirt. The thrust block or bearing was filled with oil, and in two years' service no taking up of the collars was found necessary.

One mistake I made in taking notes was not to put a date on the cards. I am now using a typewriter when I copy out my notes, and I find that in so doing I have a very much more satisfactory record.

Trial Trip from Middlesbrough

On December 20, 1919, the S. S. *Cilurnum*, built by Sir Raylton Dixon & Company, Ltd., Middlesbrough, proceeded to sea for her official trials. The steamer is a "C" type standard ship acquired from the Shipping Controller by Messrs. Hall Brothers Steamship Company, Ltd., Newcastle-on-Tyne.

The vessel is of the single-deck type with poop, bridge and forecastle, her principal dimensions being 331 feet by 46 feet 6 inches by 25 feet 6 inches molded. She has been built under special survey to receive British Corporation classification.

The vessel has five holds, five hatches and is fitted with two masts, two derrick posts, ten derricks, six winches and all the latest arrangements for the rapid handling of cargo.

Triple-expansion engines, having cylinders 25 inches, 41 inches and 68 inches diameter by 45 inches stroke, supplied with steam by three large single-ended boilers working at 180 pounds pressure, have been fitted by Messrs. Richardsons, Westgarth & Company, Ltd., Middlesbrough.

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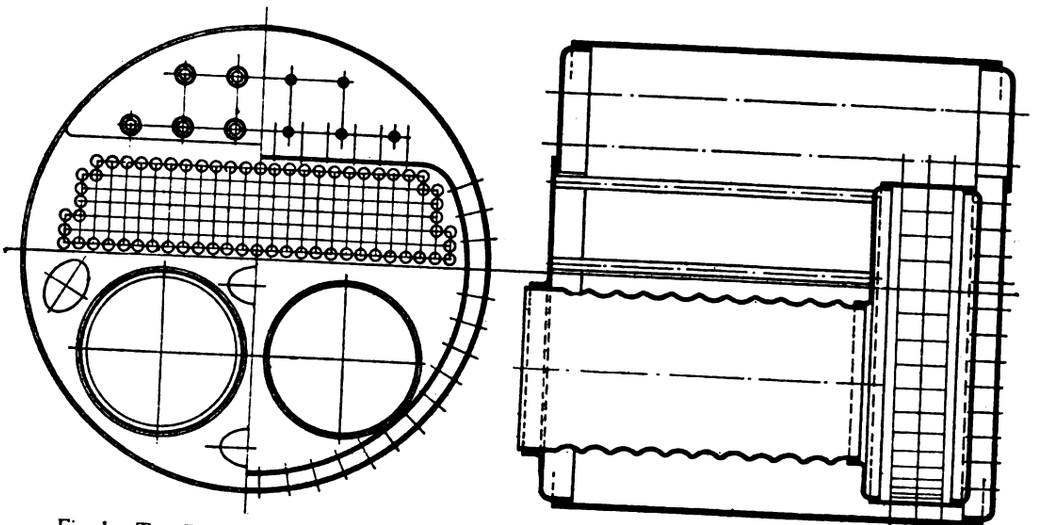

Fig. 1.—Two-Furnace Scotch Boiler, 11 Feet Long and 11 Feet Diameter, Designed by Aid of Charts

Standardization of Scotch Boilers*

The Application of Standardization and Graphical Methods to the Design of Cylindrical Return Tubular Boilers

BY HENRY C. E. MEYER

In Great Britain a committee appointed by the Institution of Naval Architects, North East Coast Institution of Engineers and Shipbuilders, Institution of Shipbuilders and Engineers in Scotland, Liverpool Engineering Society and Institute of Marine Engineers has investigated the extent to which the principle of standardization can be applied to the propelling machinery of vessels. The most important feature of the work carried out by this committee was the development of a standard set of requirements, in so far as the structural strength of the boilers was concerned, which were recommended for adoption by the various authorities which have to do with the inspection and classification of marine boilers. This parallels the work done in this country by the American Society of Mechanical Engineers for stationary boilers when they formulated their "Boiler Code," and is a decided step in the right direction, since the existence of different rules for the same purpose evidently tends to annoyance and confusion, and in many cases imposes a handicap on the builders.

AS this paper is devoted entirely to boilers of the so-called Scotch type, which are subject to faulty design, due to the designer lacking sufficient previous data to build upon, an effort is made to supply data which will enable any designer to plan a boiler which will give good results. It is hoped that the data given may at least be a step in the direction of obtaining more uniformity of design and possibly lead to the adoption of standard designs of boilers.

In order to obtain a successful boiler, two factors of primary importance are more or less dependent, one upon the other. These factors are heating surface and steam space. It would appear that the easiest steaming boiler is not always the one which contains the greatest amount of heating surface, and some very satisfactory boilers have contained only a comparatively small amount of heating surface for their size.

On the other hand, optimism as regards the amount of heating surface that can be crowded into a boiler is one of the primary causes resulting in designs wherein the principal characteristics are not properly balanced, and wherein conditions affecting accessibility, etc., are neglected.

We cannot sacrifice steam space indefinitely, nor can a boiler that is inaccessible have a long or satisfactory life. Steam space is undoubtedly one of the primary requisites to the proper performance of boilers, and it would appear that for ocean-going vessels an average practice is to keep the center of the upper row of tubes at one-sixth of the diameter of the boiler above the center-line, whereas for coastwise or harbor vessels this distance is approximately one-fifth of the diameter, and these proportions have been rigidly adhered to in preparing the data for this paper.

Only two types of Scotch boilers have been considered, i. e., those with separate combustion chambers and those with a common combustion chamber, and while there are other variations they are not by any means common. The separate combustion chamber type is more particularly suitable for ocean-going service, whereas the common combustion chamber type is used principally for coastwise and tugboat service. When forced draft is used the separate combustion chamber becomes almost essential.

Perhaps one of the best reasons for adhering to the

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.

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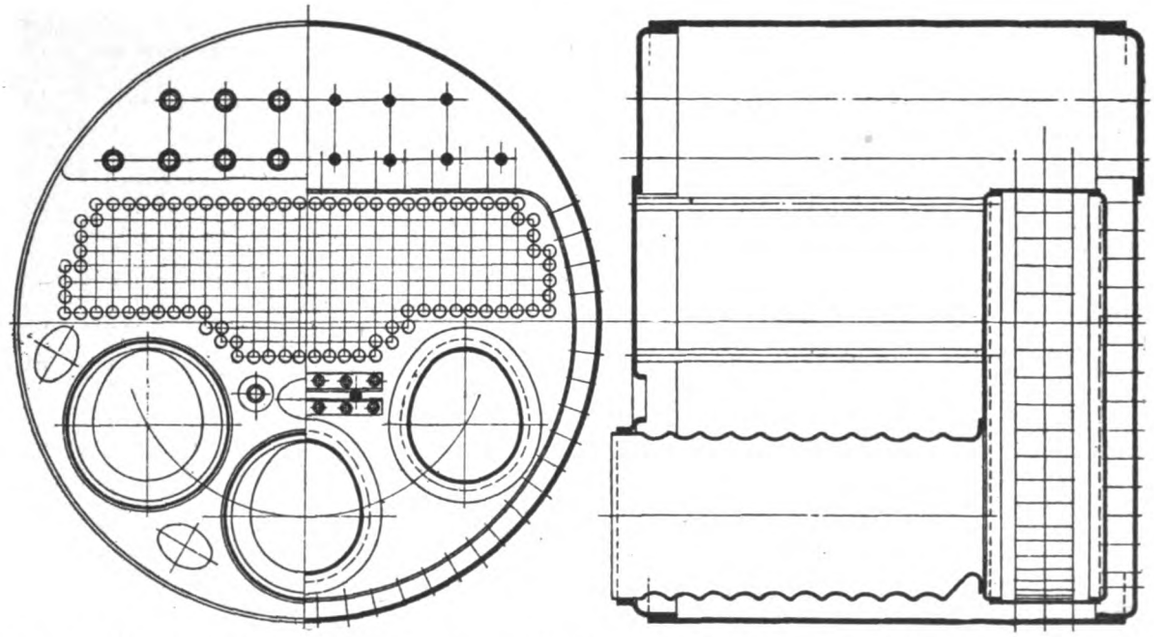

Fig. 2.—Three-Furnace Boiler, 13 Feet Diameter and 11 Feet Long. Heating Surface, 2,050 Square Feet; Grate Area, 60 Square Feet

separate combustion chamber type of boiler for ocean-going vessels lies in the fact that the interior of this type of boiler is so readily accessible for cleaning purposes, and there can be no doubt that a boiler which is examined and thoroughly cleaned at regular intervals is going to give the best service and have the longest life.

It is not the intention to discuss in this paper the methods for arriving at the heating and grate surface required to develop a given power, but rather to determine upon the dimensions of a boiler to give a predetermined heating surface. While the determination of the heating and grate surface required ought to be based upon actual steam consumption, it is to be regretted that there exists very little published data, determined by actual trial, as to the real consumption of steam by different types of marine propelling machinery, or as to the actual evaporation of water by boilers of the type under consideration.

On the other hand, there are so many successful vessels in operation to-day that the determination of the heating and grate surface is fairly simple, even though methods are used which are perhaps not quite as scientific as they might be; and, while the possession of more accurate data might enable the designer more closely to approximate his requirements with the actual performance of the boilers, in merchant vessels reasonable excess of boiler power can never be considered a fault.

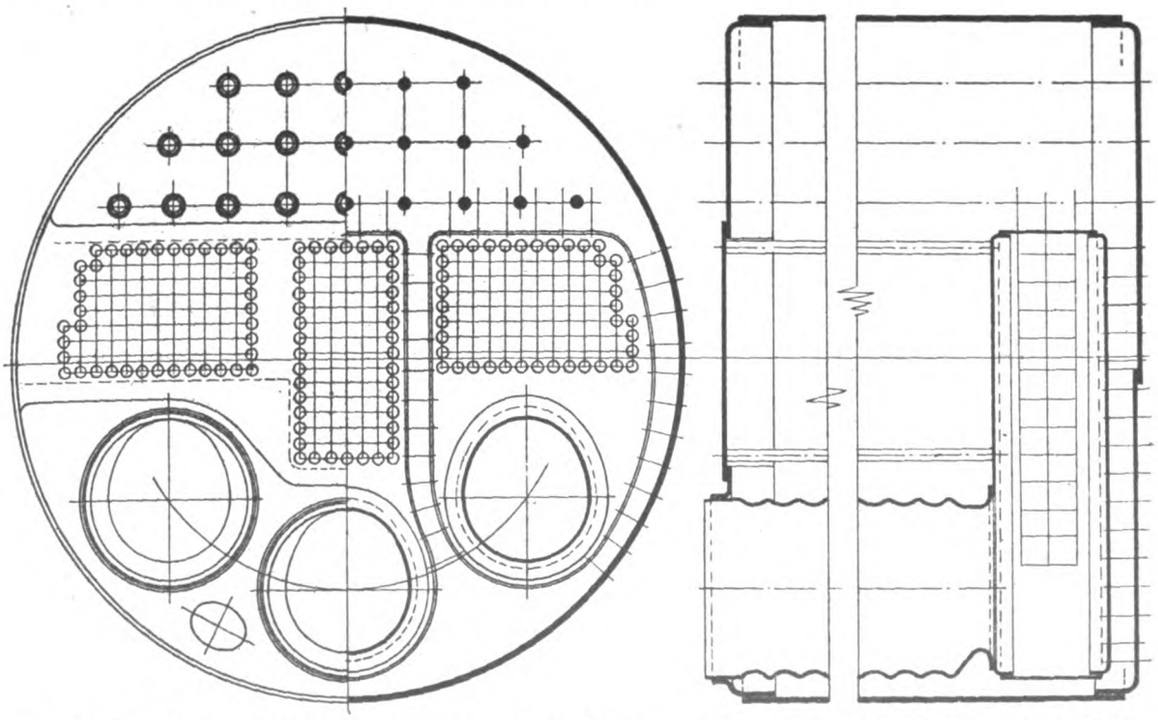

Fig. 3.—Three-Furnace Boiler, 15 feet Diameter and 11 Feet Long. Heating Surface, 2,288 Square Feet; Grate Area, 67.5 Square Feet

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The life of a boiler constantly forced to the limit is bound to be shorter than that of a boiler which readily keeps the machinery supplied with steam at a constant pressure, and it would also appear that, where fires are forced, the losses due to imperfect combustion would be greater.

Another very probable cause for the failure of boilers to steam properly lies in the fact that if the designer is limited to diameter of boiler he is apt to overestimate the amount of heating surface that can be placed in a boiler of a given size; and, while there is no doubt that the heating surface which is contained in most boilers could be considerably increased by reducing the available steam space or by crowding the tubes, it is very much to be doubted whether the boilers would be improved thereby.

The writer has come across cases where the heating surface has been increased by keeping the tubes very close to the furnaces; and, while the calculated heating surface was thereby increased, it is quite possible that the elimination of all the tubes which were in close proximity to the furnaces would not have had any appreciable effect on the steaming qualities of the boiler.

One of the causes of the great differences existing in designs lies in the fact that prior to the war, when the individual shipyards of this country were engaged on many different types of vessels at the same time, ranging from ferryboats to big passenger liners, the conditions were not favorable to the development of standard designs. A design for a 10-foot diameter boiler might be followed by another for a 15-foot boiler, and this again by a design for a 13-foot boiler. Each case being developed upon its own merits, it was to be expected that regular progression of the various proportions of different boilers would be given but scant consideration, with the result that in some cases boilers of varying diameters had the same heating surface and diameter of furnace.

With this condition in mind, the writer at one time made a series of designs progressing at the rate of 3 inches in diameter of boiler, which designs proved that a regular progression of dimensions could be maintained and that the resultant designs would have well-balanced proportions.

The designs referred to were limited to boilers with separate combustion chambers for forced draft, and boilers with common combustion chambers for natural draft, all with three or four furnaces, but did not cover two-furnace boilers.

In the accompanying diagrams boilers with separate combustion chambers for natural draft have also been included, and the diagrams for boilers with common combustion chambers have been extended to include two-furnace boilers. While some two-furnace boilers are fitted with separate combustion chambers, these boilers generally are small, as in the case of small vessels for coastwise or harbor service or of donkey boilers, and it would seem that a common combustion chamber type would be equally acceptable in such cases and would be considerably cheaper to construct.

FURNACES

The diameter of furnace that can be used conveniently in a boiler of a given size is a question that may be open to considerable discussion. It is, however, one of the first and most important features of design, since a furnace too large will result in either unduly crowding the tubes and reducing the steam space available or having an insufficient amount of heating surface and area through tubes, whereas a furnace too small in diameter will result in poor combustion and insufficient grate surface.

In determining upon a standard design, therefore, the diameter of the furnace should be a prime factor, and Fig. 4 gives furnace diameters which not only are in accord with average practice but which increase systematically in proportion to the diameter of the boiler.

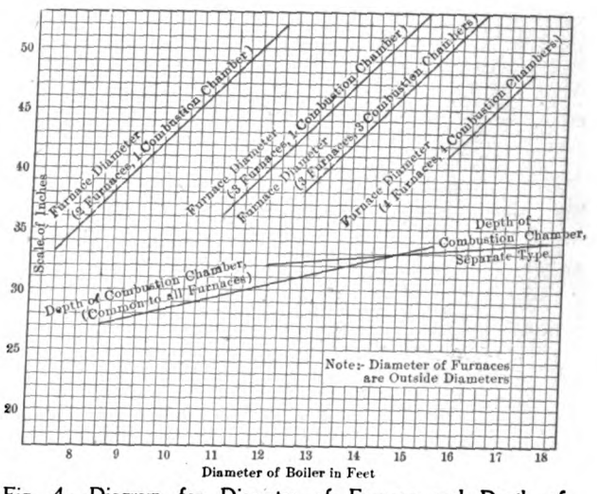
Scale of Inches
Furnace Diameter (2 Furnaces, 1 Combustion Chamber)
Furnace Diameter (3 Furnaces, 1 Combustion Chamber)
Furnace Diameter (3 Furnaces, 3 Combustion Chambers)
Furnace Diameter (4 Furnaces, 4 Combustion Chambers)
Depth of Combustion Chamber, Separate Type
Depth of Combustion Chamber (Common to all Furnaces)
Note:- Diameter of Furnaces are Outside Diameters
Diameter of Boiler in Feet

Fig. 4.—Diagram for Diameter of Furnace and Depth of Combustion Chamber

Attention is again drawn to the fact that there seems to be considerable difference of opinion on this subject, some builders using smaller, others larger furnaces, but the dimensions given will ensure a well-balanced design when all the other features have been taken into account, such as the ratios between heating and grate surface and between area through tubes and grate surface.

It should be remembered that in Fig. 4 the diameters of furnaces given are the extreme outside diameters and not the effective diameters.

TUBES

While there are many different sizes of tubes used, the most common practice seems to be to use 3-inch outside diameter tubes for natural and 2½-inch outside diameter tubes for forced draft.

It is evident that by the use of smaller tubes the heating surface in a boiler can be increased, but there seems to be no really sound reason why in a series of standard designs of boilers the above diameters could not be adhered to.

Fig. 5 gives the number of tubes for each size of boiler.

At this point it is well to note that the number of tubes which can be placed in boilers of a standard type and with standard characteristics will not give quite as regular a curve as plotted on the above diagrams.

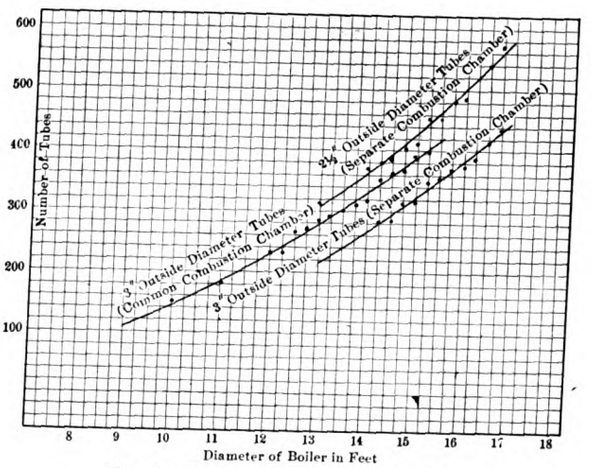
Number of Tubes
2½" Outside Diameter Tubes (Separate Combustion Chamber)
3" Outside Diameter Tubes (Common Combustion Chamber)
3" Outside Diameter Tubes (Separate Combustion Chamber)
Diameter of Boiler in Feet

Fig. 5.—Diagram for Number of Tubes

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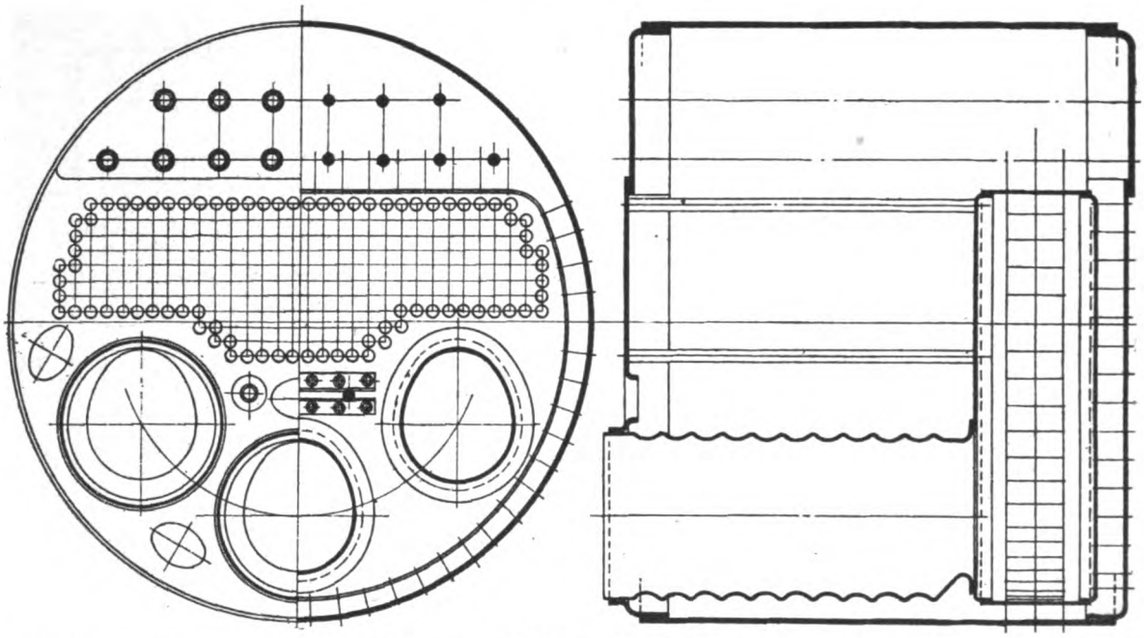

Fig. 2.—Three-Furnace Boiler, 13 Feet Diameter and 11 Feet Long. Heating Surface, 2,050 Square Feet; Grate Area, 60 Square Feet

separate combustion chamber type of boiler for ocean-going vessels lies in the fact that the interior of this type of boiler is so readily accessible for cleaning purposes, and there can be no doubt that a boiler which is examined and thoroughly cleaned at regular intervals is going to give the best service and have the longest life.

It is not the intention to discuss in this paper the methods for arriving at the heating and grate surface required to develop a given power, but rather to determine upon the dimensions of a boiler to give a predetermined heating surface. While the determination of the heating and grate surface required ought to be based upon actual steam consumption, it is to be regretted that there exists very little published data, determined by actual trial, as to the real consumption of steam by different types of marine propelling machinery, or as to the actual evaporation of water by boilers of the type under consideration.

On the other hand, there are so many successful vessels in operation to-day that the determination of the heating and grate surface is fairly simple, even though methods are used which are perhaps not quite as scientific as they might be; and, while the possession of more accurate data might enable the designer more closely to approximate his requirements with the actual performance of the boilers, in merchant vessels reasonable excess of boiler power can never be considered a fault.

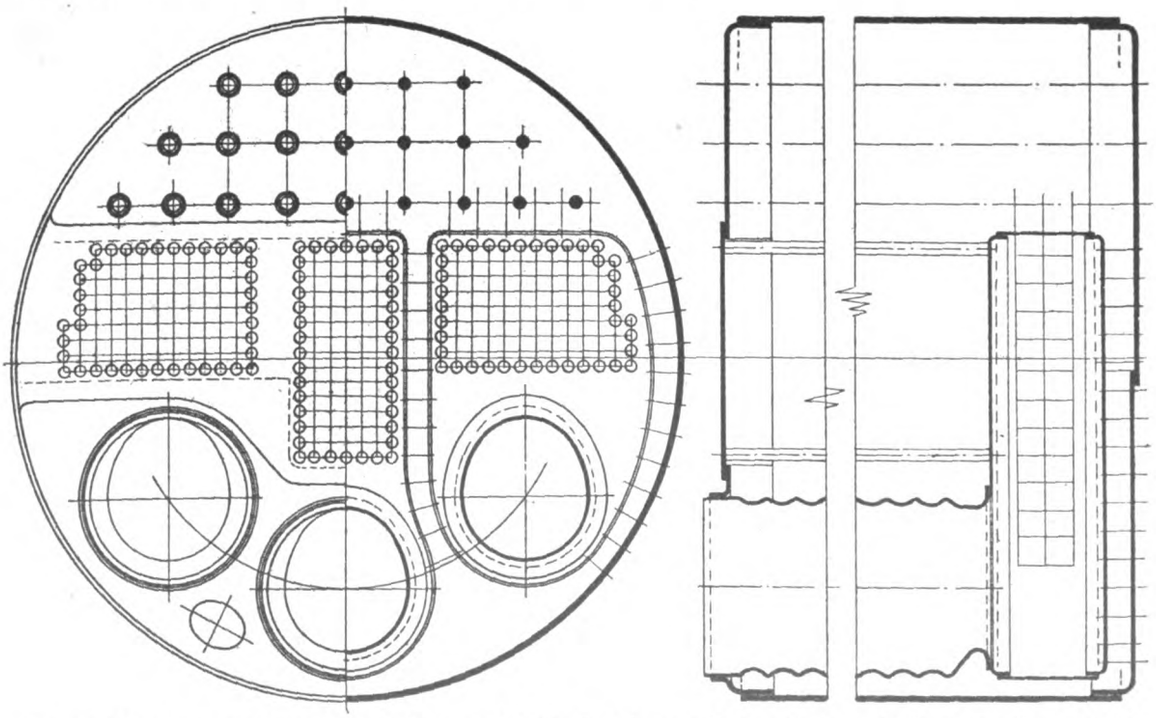

Fig. 3.—Three-Furnace Boiler, 15 feet Diameter and 11 Feet Long. Heating Surface, 2,288 Square Feet; Grate Area, 67.5 Square Feet

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The life of a boiler constantly forced to the limit is bound to be shorter than that of a boiler which readily keeps the machinery supplied with steam at a constant pressure, and it would also appear that, where fires are forced, the losses due to imperfect combustion would be greater.

Another very probable cause for the failure of boilers to steam properly lies in the fact that if the designer is limited to diameter of boiler he is apt to overestimate the amount of heating surface that can be placed in a boiler of a given size; and, while there is no doubt that the heating surface which is contained in most boilers could be considerably increased by reducing the available steam space or by crowding the tubes, it is very much to be doubted whether the boilers would be improved thereby.

The writer has come across cases where the heating surface has been increased by keeping the tubes very close to the furnaces; and, while the calculated heating surface was thereby increased, it is quite possible that the elimination of all the tubes which were in close proximity to the furnaces would not have had any appreciable effect on the steaming qualities of the boiler.

One of the causes of the great differences existing in designs lies in the fact that prior to the war, when the individual shipyards of this country were engaged on many different types of vessels at the same time, ranging from ferryboats to big passenger liners, the conditions were not favorable to the development of standard designs. A design for a 10-foot diameter boiler might be followed by another for a 15-foot boiler, and this again by a design for a 13-foot boiler. Each case being developed upon its own merits, it was to be expected that regular progression of the various proportions of different boilers would be given but scant consideration, with the result that in some cases boilers of varying diameters had the same heating surface and diameter of furnace.

With this condition in mind, the writer at one time made a series of designs progressing at the rate of 3 inches in diameter of boiler, which designs proved that a regular progression of dimensions could be maintained and that the resultant designs would have well-balanced proportions.

The designs referred to were limited to boilers with separate combustion chambers for forced draft, and boilers with common combustion chambers for natural draft, all with three or four furnaces, but did not cover two-furnace boilers.

In the accompanying diagrams boilers with separate combustion chambers for natural draft have also been included, and the diagrams for boilers with common combustion chambers have been extended to include two-furnace boilers. While some two-furnace boilers are fitted with separate combustion chambers, these boilers generally are small, as in the case of small vessels for coastwise or harbor service or of donkey boilers, and it would seem that a common combustion chamber type would be equally acceptable in such cases and would be considerably cheaper to construct.

FURNACES

The diameter of furnace that can be used conveniently in a boiler of a given size is a question that may be open to considerable discussion. It is, however, one of the first and most important features of design, since a furnace too large will result in either unduly crowding the tubes and reducing the steam space available or having an insufficient amount of heating surface and area through tubes, whereas a furnace too small in diameter will result in poor combustion and insufficient grate surface.

In determining upon a standard design, therefore, the diameter of the furnace should be a prime factor, and Fig. 4 gives furnace diameters which not only are in accord with average practice but which increase systematically in proportion to the diameter of the boiler.

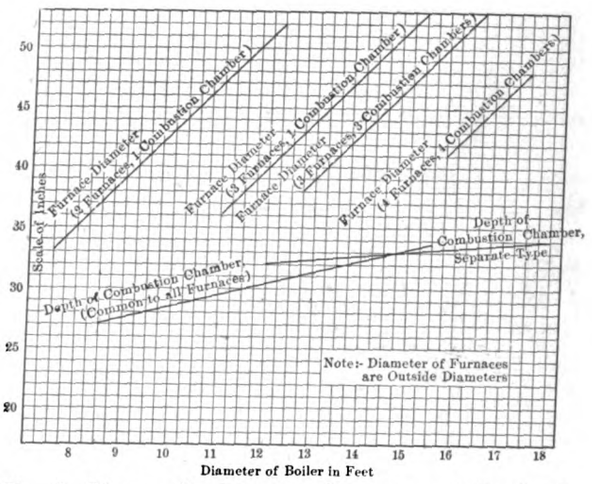
Scale of Inches
Furnace Diameter (3 Furnaces, 1 Combustion Chamber)
Furnace Diameter (3 Furnaces, 1 Combustion Chamber)
Furnace Diameter (3 Furnaces, 3 Combustion Chambers)
Furnace Diameter (4 Furnaces, 4 Combustion Chambers)
Depth of Combustion Chamber, Separate Type
Depth of Combustion Chamber (Common to all Furnaces)
Note:- Diameter of Furnaces are Outside Diameters
Diameter of Boiler in Feet

Fig. 4.—Diagram for Diameter of Furnace and Depth of Combustion Chamber

Attention is again drawn to the fact that there seems to be considerable difference of opinion on this subject, some builders using smaller, others larger furnaces, but the dimensions given will ensure a well-balanced design when all the other features have been taken into account, such as the ratios between heating and grate surface and between area through tubes and grate surface.

It should be remembered that in Fig. 4 the diameters of furnaces given are the extreme outside diameters and not the effective diameters.

TUBES

While there are many different sizes of tubes used, the most common practice seems to be to use 3-inch outside diameter tubes for natural and 2½-inch outside diameter tubes for forced draft.

It is evident that by the use of smaller tubes the heating surface in a boiler can be increased, but there seems to be no really sound reason why in a series of standard designs of boilers the above diameters could not be adhered to.

Fig. 5 gives the number of tubes for each size of boiler.

At this point it is well to note that the number of tubes which can be placed in boilers of a standard type and with standard characteristics will not give quite as regular a curve as plotted on the above diagrams.

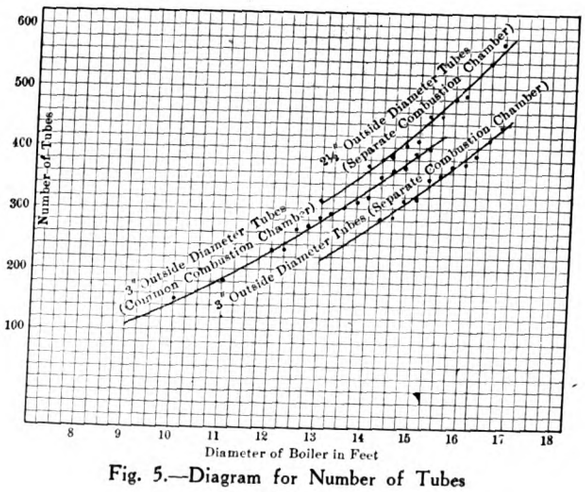
Number of Tubes
2½" Outside Diameter Tubes (Separate Combustion Chamber)
3" Outside Diameter Tubes (Separate Combustion Chamber)
3" Outside Diameter Tubes (Common Combustion Chamber)
3" Outside Diameter Tubes
Diameter of Boiler in Feet

Fig. 5.—Diagram for Number of Tubes

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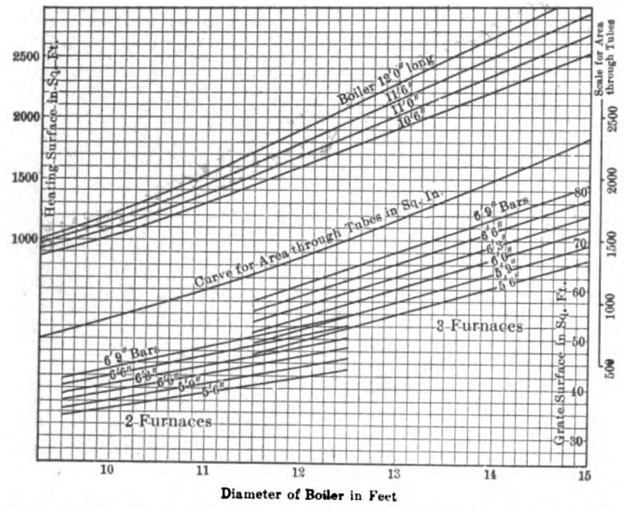

Fig. 6.—Diagram for Heating and Grate Surface and Area Through Tubes for Cylindrical Return Tubular Boilers, Common Combustion Chamber Type. 3-Inch Outside Diameter Tubes

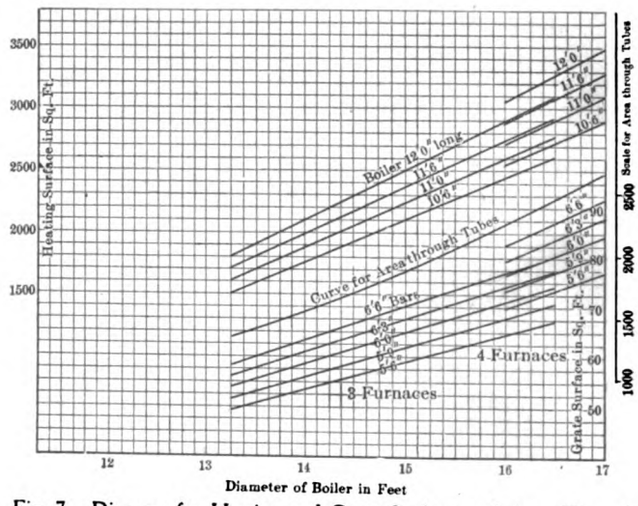

Fig. 7.—Diagram for Heating and Grate Surface and Area Through Tubes for Cylindrical Return Tubular Boilers, Separate Combustion Chamber Type. 3-Inch Outside Diameter Tubes

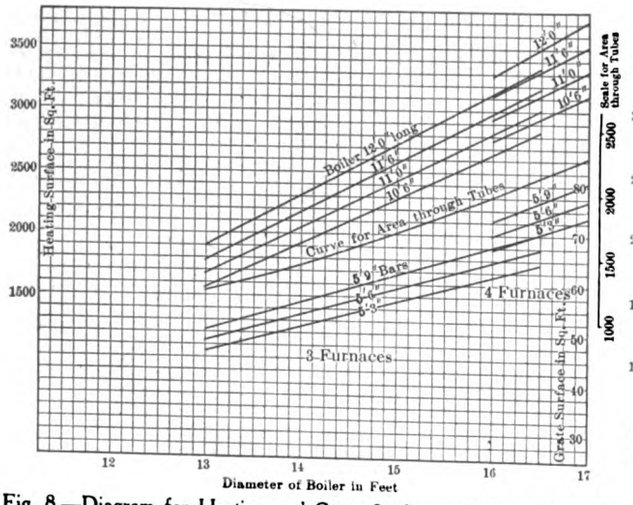

Fig. 8.—Diagram for Heating and Grate Surface and Area Through Tubes for Cylindrical Return Tubular Boilers, Separate Combustion Chamber Type. 2½-Inch Outside Diameter Tubes

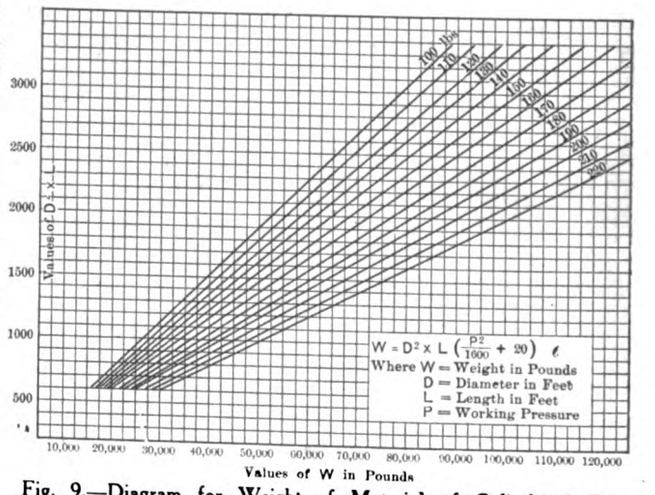
Values of D² x L
W = D² x L (P²/1600 + 20)
Where W = Weight in Pounds
D = Diameter in Feet
L = Length in Feet
P = Working Pressure
Values of W in Pounds

Fig. 9.—Diagram for Weight of Material of Cylindrical Return Tubular Marine Boilers. Common Combustion Chamber Type. Weight Given in Pounds

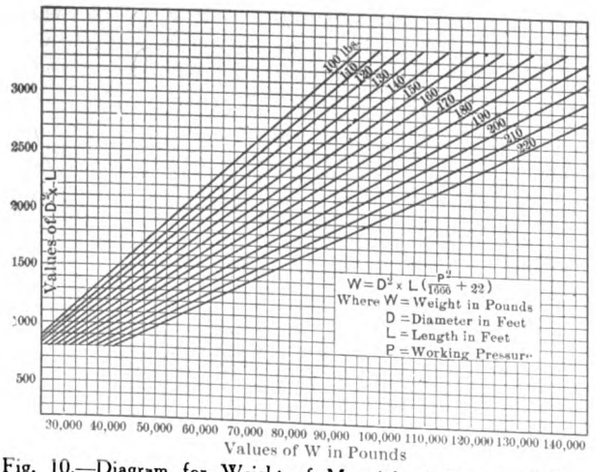
Values of D² x L
W = D² x L (P²/1600 + 22)
Where W = Weight in Pounds
D = Diameter in Feet
L = Length in Feet
P = Working Pressure
Values of W in Pounds

Fig. 10.—Diagram for Weight of Material of Cylindrical Return Tubular Marine Boilers. Separate Combustion Chamber Type

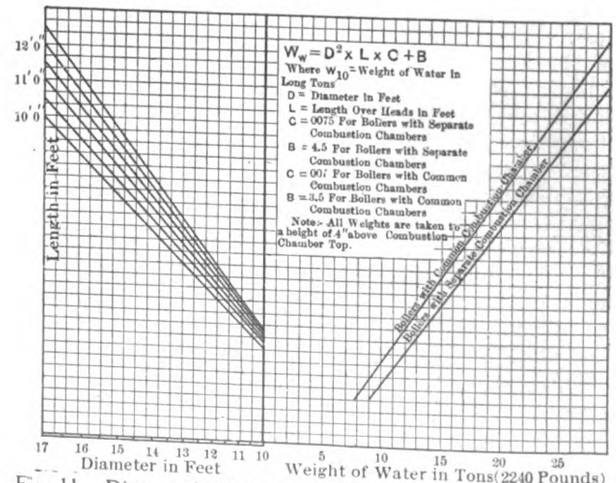
Length in Feet
Ww = D² x L x C + B
Where Ww = Weight of Water in Long Tons
D = Diameter in Feet
L = Length Over Heads in Feet
C = 0075 For Boilers with Separate Combustion Chambers
B = 4.5 For Boilers with Separate Combustion Chambers
C = 007 For Boilers with Common Combustion Chambers
B = 3.5 For Boilers with Common Combustion Chambers
Note:- All Weights are taken to a height of 4" above Combustion Chamber Top.
Boilers with Common Combustion Chamber
Boilers with Separate Combustion Chamber
Diameter in Feet
Weight of Water in Tons (2240 Pounds)

Fig. 11.—Diagram for Determining Weight of Water in Cylindrical Return Tubular Marine Boilers

The spots indicated on the diagrams give the actual number in the case of some standard designs actually worked out, and it will be noted that at various points a step occurs in the curve. This step is due to the fact that when the point is reached where, due to the increase in size of the boiler, it becomes possible to add another

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horizontal row of tubes, the number of tubes is increased somewhat rapidly.

As regards the length of the tubes, this is of course dependent upon the length of the boiler, depth of combustion chamber and depth of water space back of the combustion chamber.

It would appear that by definitely settling upon certain desired characteristics of boilers, i.e., the ratio of heating to grate surface and the ratio of area through tubes to grate surface, the lengths of a complete series of boilers could be kept down to very few different dimensions, which would result in the possibility of keeping the tubes of certain standard lengths, possibly only three or four lengths being required, which would enable both the manufacturers and boiler makers to keep stocks of tubes for ready use.

It would also have the further advantage that the lengths of furnace could be kept standard, and there is no reason why these should not be made to standard dimensions throughout, which again would make possible the standardization of furnace fittings.

Anyone familiar with repair shop practice knows that unless each vessel is provided with patterns for the side bars for each furnace, whenever it becomes necessary to renew same, new patterns have to be made and fitted to each furnace, which in itself constitutes a serious economic waste.

Lastly, the boiler maker would be benefited by the fact that all longitudinal stays could be made of standard dimensions.

Combustion Chambers

The depth of combustion chambers used in connection with these diagrams has been plotted on Fig. 4. The proportions given are quite sufficient for coal burning and generally should be sufficient when burning oil, although some designers prefer to use a greater depth in the latter case.

It should be kept in mind that the dimensions given are inside dimensions, and the actual depth used should be stated in even inches, which will somewhat simplify the calculations for allowable pressures on plates, stays and girders, etc.

Heating and Grate Surface

Based upon the dimensions for furnaces and combustion chambers given by Fig. 4 and upon the numbers of tubes given by Fig. 5, the diagrams for heating surface, grate surface and area through tubes have been constructed.

By reference to Figs. 6, 7 and 8 it is possible to quickly estimate how much heating surface may be expected from a boiler of certain dimensions or, knowing the heating surface required, what size boiler is needed. In this connection the writer would again point to the comparative scarcity of published data on the performance and efficiency of Scotch boilers.

The different authorities on the subject give figures for heating surface required that vary widely, and there is no doubt that the tendency to keep the boilers too small is somewhat of a temptation when costs have to be kept down.

After all, the most reliable data for designing boilers are not the result of builders' trials when all conditions are favorable, but rather the average result of actual long voyages of vessels which are no longer new but which have been in operation some time.

There is no doubt but that it might mean some expense to the shipowner to obtain these results, as in many vessels the apparatus for indicating the engines is taken down after the builders' trials and never used again. On the other hand, a careful investigation of the performance of a vessel not giving satisfactory service would probably result in the adverse conditions being eliminated, with consequent advantage to the owners.

As a guide to what can be accomplished, the writer offers the following data taken from actual performance during long voyages of a tramp steamer:

Boilers

Number	Two
Type	Single-end Scotch
Draft	Howden's
Heating surface, total	4,464 square feet
Grate surface, total	104 square feet
H. S. / G. S.	44

Engines

Cylinders, inches	24-40-67
Stroke, inches	45
Average revolutions	65
Pressure at throttle, pounds per square inch	195
Indicated horsepower	1,600

Auxiliaries

Air pump	Lever-driven
Circulating pump	Lever-driven
Feed pump	Lever-driven
Bilge pumps	Lever-driven
Blower engine	Independent reciprocating
Electric generator	Independent reciprocating
Steering engine	Independent

Consumption of Fuel

Type of coal	Welsh
Coal in 24 hours	24 tons
Indicated horsepower per square foot grate surface	15.4
Coal per indicated horsepower	1.4 pounds
Air pressure at blower	1⅜ inches

The above figures are given as the writer is thoroughly familiar with the particular case and knows that this vessel gave very satisfactory results on voyages of from eighteen to twenty-one days' duration from port to port.

In addition to the diagrams giving the characteristics of designs of a series of boilers, the writer has added diagrams for obtaining the weight of material entering into construction of a boiler and also the weight of water. The weights of materials are gross weights and do not include fittings.

In examining the diagrams it is, of course, impossible for anyone not familiar with the designs whereon same are based to decide at a glance whether these diagrams will give proportions that are reasonable. For this purpose the writer has prepared Figs. 1, 2 and 3, which boilers were designed from data taken direct from the diagrams given. These designs do not present any unusual features, and in preparing them no difficulty was experienced in obtaining the proportions which the charts predicted. The arrangement of tubes was kept as simple as possible in order to avoid unnecessary complication of the smoke boxes, since the few additional tubes that might have been added would only be of doubtful value, anyway.

The diagrams may be used very readily for making a table of standard boilers, and it is to be hoped that the data as given may prove of some benefit to the designer who has not at his disposal a number of designs which have proven to be successful. For the designer who has already a great number of designs available, it may follow that the methods outlined in this paper may be of benefit in co-ordinating his various dimensions of boilers. The following example of the use of the diagrams may possibly demonstrate their value somewhat more clearly:

Let us suppose that it is desired to design a boiler having the following characteristics:

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Type ..... Separate combustion chamber
Heating surface ..... 2,200 square feet
Grate surface $= \frac{\text{H. S.}}{34}$ ..... 66.3 square feet
Area through tubes not less than ..... 1,800 square inches
Grates not longer than ..... 6 feet 3 inches
Draft ..... Natural

Since the length of grate bar is fixed, the grate area will be the determining feature as to the diameter of the boiler.

By reference to Fig. 7 it will be seen that bars 6 feet 3 inches long will give a grate surface of 67.5 square feet in the case of a boiler 15 feet diameter, i. e., the diameter of furnaces appropriate to this diameter of boiler is such as to give this amount of grate surface.

The same diagram also shows that if this boiler is made 11 feet long we will have 2,200 square feet of heating surface and an area through the tubes of 1,890 square inches.

The diameter of the furnace can next be obtained from Fig. 4 and is found to be 3 feet 11 inches outside, while the depth of combustion chamber would be 33 inches.

Fig. 5 gives the number of tubes as 320.

Allowing a water space of 9 inches at the back of the combustion chamber and 3 inches for the total thickness of heads, and combustion chamber back and tube sheets, the length of tubes between sheets is 7 feet 3 inches.

The weight of water obtained from Fig. 11 will be 20.6 long tons.

The above results may now be compared with the results actually obtained in the design illustrated by Fig. 3, which results were calculated.

	Estimated	Actual
Diameter	15 feet 0 inches	15 feet 0 inches
Length	11 feet 0 inches	11 feet 0 inches
Diameter of furnaces	3 feet 11 inches	3 feet 11 inches
Number of tubes.	320	327
Effective length of tubes	7 feet 3 inches	7 feet 3 inches
Heating surface, square feet.....	2,220	2,288
Grate surface, square feet.....	67.5	67.5
Area through tubes	1,890	1,962
Depth of combustion chamber...	2 feet 9 inches	2 feet 9 inches
Weight of boiler.	102,500 pounds	
Weight of water..	23.2 tons	

It will be seen that the design in Fig. 3 closely approximates the desired characteristics and that specifications can be quickly prepared by this method.

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Fig. 1.—Application of Truscon Type Steel Windows to the Freight House of the New York Shipbuilding Corporation

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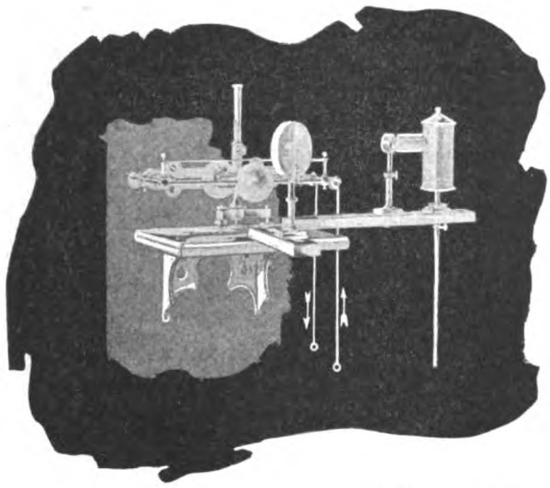

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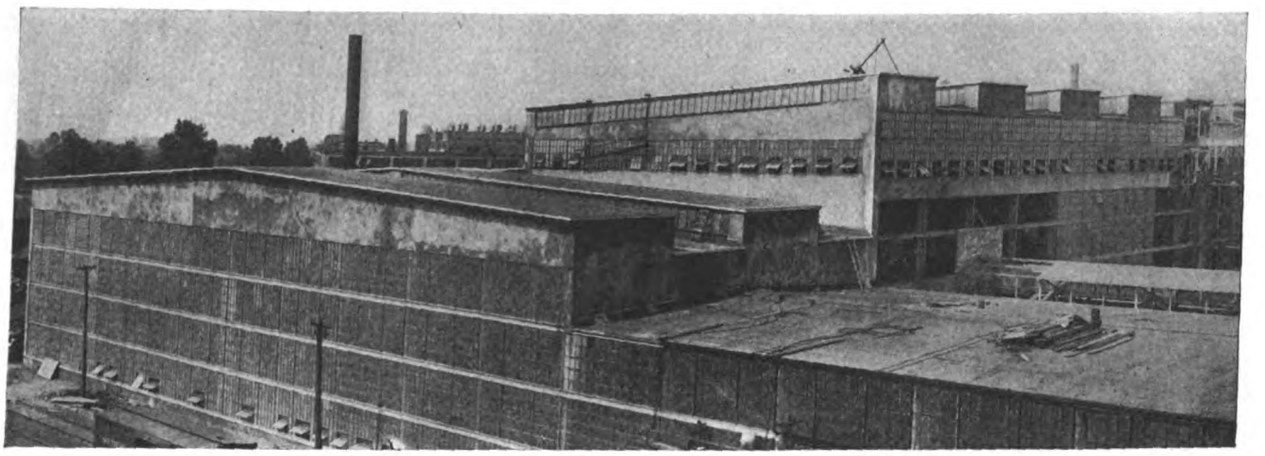

Fig. 2.—All Shops of the New York Shipbuilding Corporation Utilize the Modern Window Lighting Arrangements Exemplified by the Plate and Angle Shop Shown in This Illustration

obtain the maximum lighting effect without artificial means.

As a result of this, they adopted a standard for all their buildings, which consisted of a structural steel framework with a steel sash on practically the entire exterior, the small portion not occupied by the sash walls being filled in with a 2-inch plastered wall on metal lath. The freight house and the plate and angle shop shown in Figs. 1 and 2 respectively illustrate the wide expanse of sash wall used throughout the entire plant.

Lighting Investigations Here and Abroad

The subject of lighting industrial buildings has been very carefully and exhaustively studied by the Illuminating Engineering Society in this country and by the Departmental Committee on Lighting in Factories and Workshops in England, appointed by Parliament. As a result of these investigations the "daylight factor," which is the ratio of the interior to the exterior illumination at some given time of the day and at some given point of the building, taken simultaneously, was determined to be not greater than 0.25 of 1 percent where the buildings were lighted on the sides only. Obviously, with such a small percentage of daylight efficiently used on the interior, it became advisable to utilize the remainder by permitting as large a portion of light to be transmitted into the interior as possible.

The discovery of the inefficiency of ordinary window installations caused the New York Shipbuilding Corporation to use, first, the maximum amount of wall space devoted to windows; second, the maximum amount of window surface devoted to glass, and, third, as little obstruction to the entrance of light as possible.

By the use of structural steel supporting members, instead of bulky and unwieldy brick or masonry, it is possible to obtain the maximum amount of wall space devoted to light. By using steel sash with very narrow muntin bars, and by eliminating heavy jamb sections and weight boxes, the glass proportion of the window is measurably increased. This type of sash is really more economical than wood at the present time, and with the increasing scarcity of lumber is likely to remain so. By using a thin 2-inch metal lath, plastered wall, very little obstruction to the entrance of light is offered.

System Applied to Pier Lighting

The Department of Docks, Wharves and Ferries of the City of Philadelphia has also recognized these principles of construction and has used similar types of construction in many large municipal piers built under its jurisdiction within the last few years. Figs. 3 and 4 show views of one of the recently constructed Philadelphia municipal piers. In pier construction there is not, of course, as great a need for considering the daylight factor as in factory construction; in fact, a very large proportion of the wall space of the lower level of these piers consists of doors, the necessity for which is obvious. The upper deck, however, and the outshore elevations in particular, have a very large expanse of steel, narrow-muntined windows,

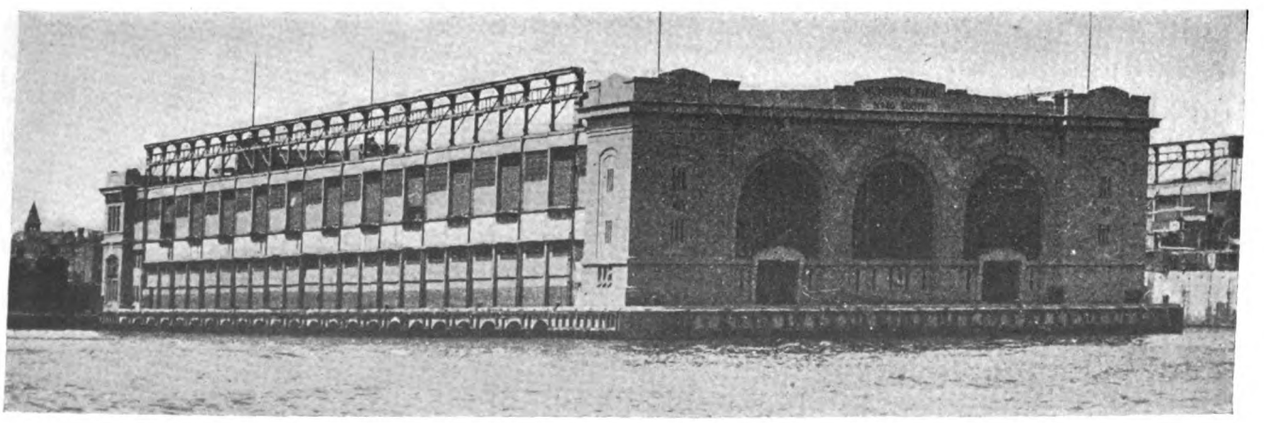

Fig. 3.—In so Far as Practicable, Modern Piers Are Well Provided with Natural Daylight, as Indicated by the Municipal Piers of Philadelphia

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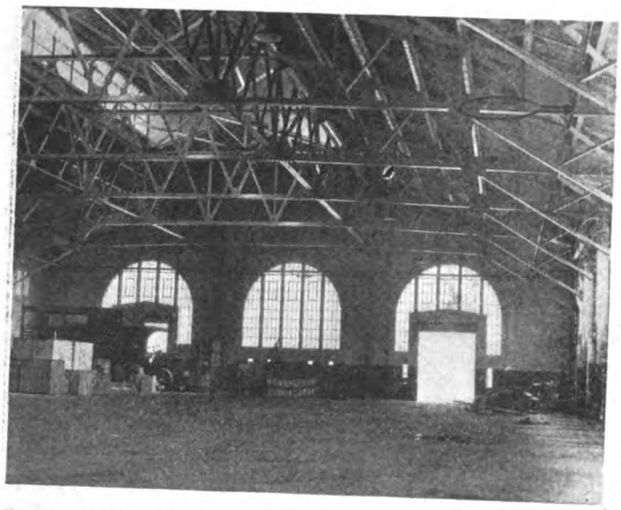

Fig. 4.—A Remarkably Good Idea of the Advantages to be Derived from Properly Designed Lighting Facilities May Be Gained from the Interior View of One of the Municipal Piers, Philadelphia

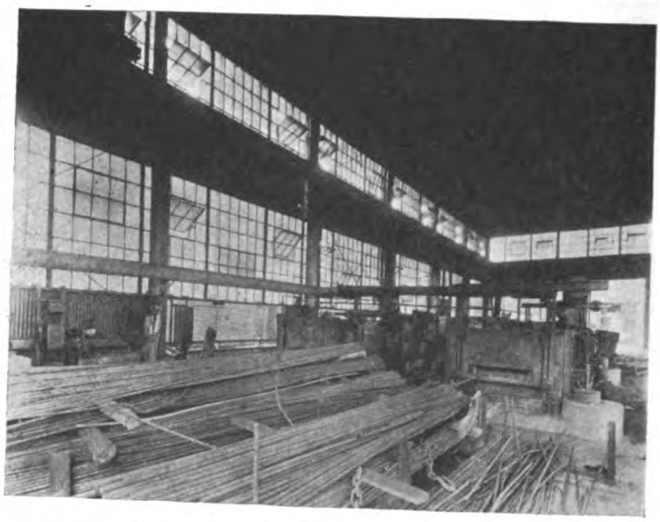

Fig. 6.—A Corner of a Hog Island Shop in Which the Daylight Factor is High

which could not have been as advantageously constructed of wood or other material.

The same type of construction as employed in the shops of the New York Shipbuilding Corporation is used to a limited extent in the buildings of the American International Shipbuilding Corporation at Hog Island, as shown in Figs. 5 and 6, excepting that the percentage of window space is not nearly so large as in the case of the New York Shipbuilding plants. Corrugated iron was used for the non-glass wall material. The corrugated iron is, of course, even thinner than the plastered walls, but it is not nearly as durable and was undoubtedly selected because of the supposedly temporary character of at least part of the Hog Island project.

Steel windows are, of course, no longer an innovation. Their use is more or less standard in the construction of buildings for all industries, but particularly in shipbuilding construction, in pier construction, and, in fact, in all types of construction wherein long buildings are required, has the application of the daylight principle proved of special advantage.

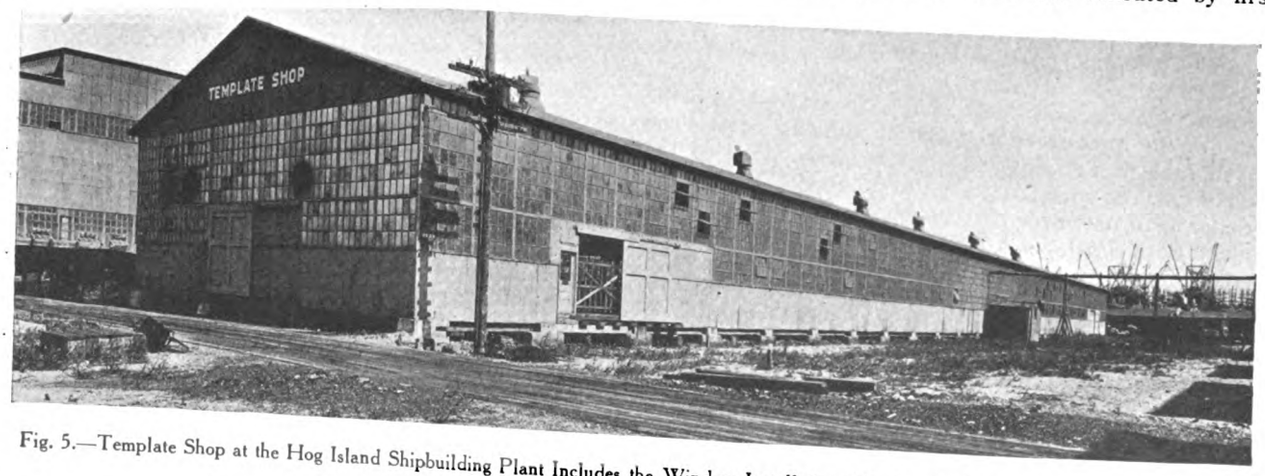

Fig. 5.—Template Shop at the Hog Island Shipbuilding Plant Includes the Window Installations Used to Light the Temporary Structures of This Plant by Natural Means

Start to warm up your engine slowly and make the start early enough to get the engine well warmed when you hear the bells to "stand by."

Italian Battleship Dry Docked Upside Down

ON the opposite page are shown photographs of the Italian battleship *Leonardo da Vinci* dry docked upside down at Taranto after being salvaged and towed into port upside down. The vessel was sunk in thirty-six feet of water in the Piccolo sea on August 2, 1916, by an explosion in the after munition stores.

When the explosion occurred the vessel turned turtle and sank in that position. She was refloated by first closing the openings in the hull and then forcing out the water by means of compressed air. She was then towed, still upside down, into the dry dock at Taranto, where the vessel was docked on timber supports arranged as shown in the photographs.

The *Leonardo da Vinci* is a battleship of 22,380 tons displacement; 575 feet 6 inches long on the waterline and 91 feet 9 inches beam, with a mean draft of 27 feet 9 inches, laid down by the Ansaldo company in 1911 and completed in 1914. Her machinery, also built by the Ansaldo company, consists of Parsons turbines of 24,000 horsepower, driving four screws, and Blechynden boilers. The vessel was designed for a speed of 22½ knots and carries an armament of thirteen 12-inch, eighteen 4.7-inch and fourteen 3-inch guns and three 18-inch torpedo tubes.

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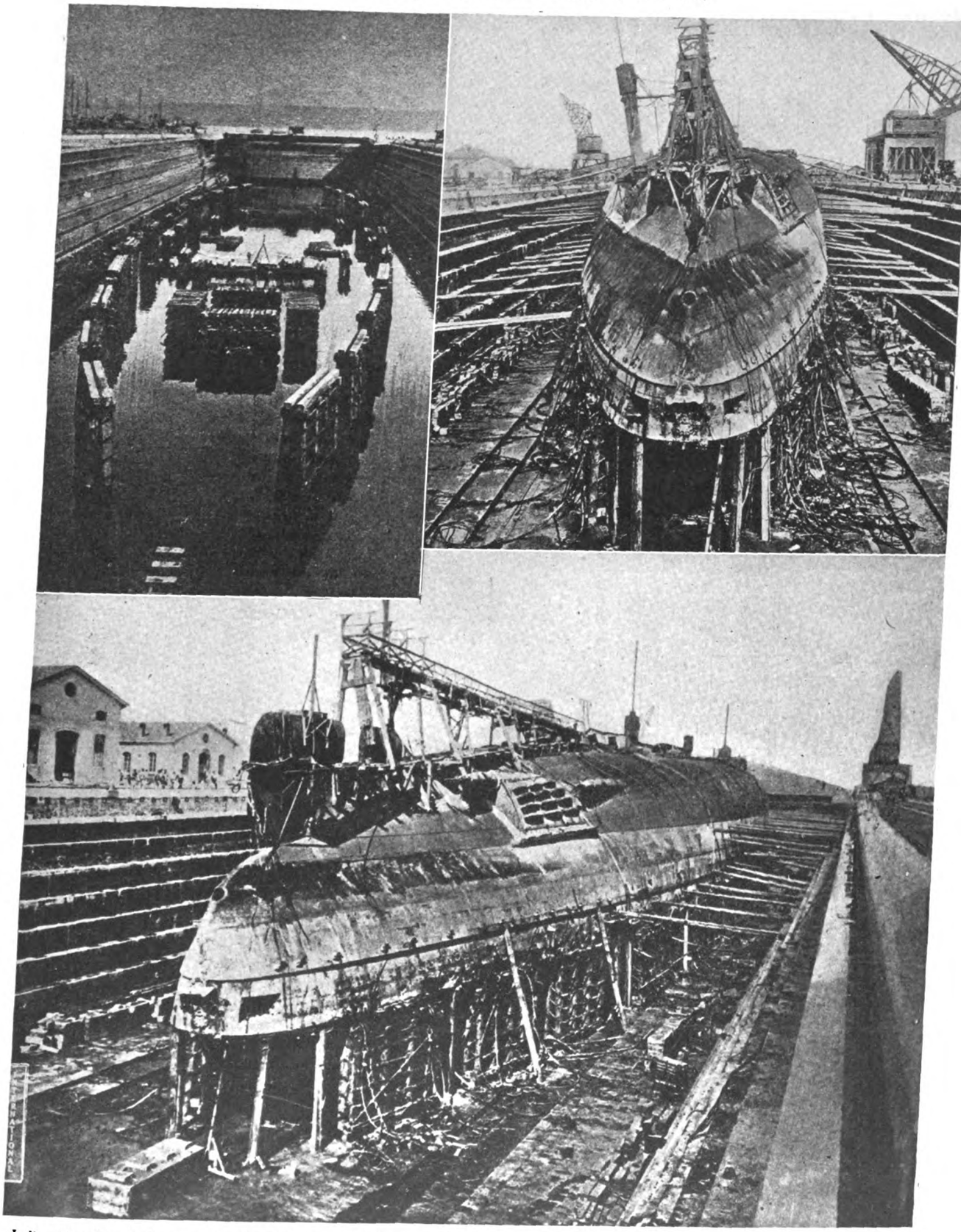
Battleship Dry Docked Upside Down

(Photographs by "International," New York)



Italian Dreadnought *Leonardo da Vinci* Resting on Timber Supports in the Drydock at Taranto After Being Salvaged at Sea and Towed Into Port Upside Down

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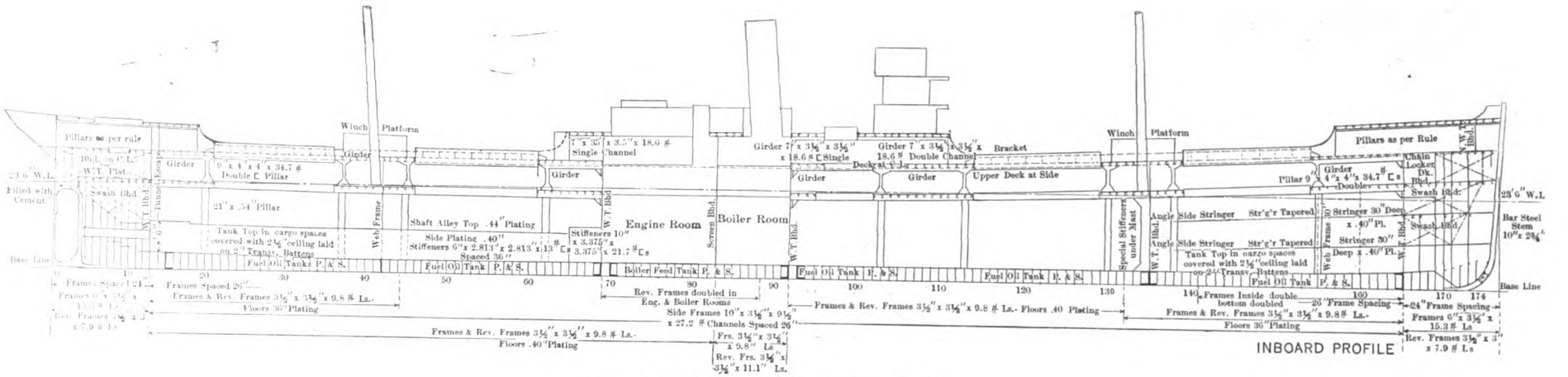

Fig. 1.—Profile of Transversely Framed Ship

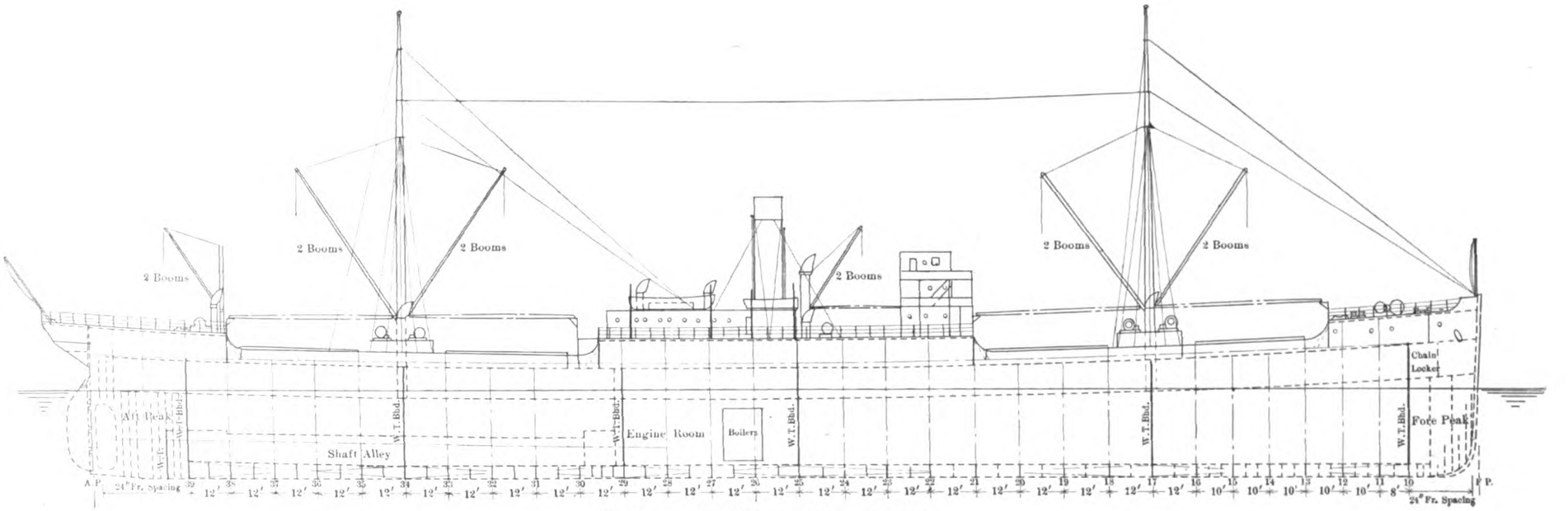

Fig. 2.—Profile of Isherwood Framed Vessel

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An Analysis of the Isherwood System*

BY JOHN FLODIN, M.E.

Are the claims for the Isherwood framed ship, not only as to increased cargo capacity, but also as to strength, true? It is the first purpose of this paper to endeavor to answer these questions in the case of one specific type of vessel, the choice of which depended on the fortunate circumstance that a western shipbuilding firm, with which the author was at the time connected, changed from the transverse to the longitudinal system of construction. Other advantages claimed for the Isherwood system will also receive consideration.

THE particulars of the design under consideration are: Length between perpendiculars, 380 feet; length overall, 395 feet; length, Lloyd's, 380 feet 3 inches; breadth, molded, 53 feet; depth, molded, 29 feet 3 inches; load draft, about 23 feet 6 inches; block coefficient, .790; deadweight cargo capacity, about 7,500 tons.

The two vessels are, as shown by the profiles (Figs. 1 and 2), of the poop, long bridge and forecastle type, and both are built to the highest class of Lloyd's Register of Shipping.

In making this change in the system of construction, several minor alterations became necessary or desirable. Thus, for example, the engine and boiler casings and the deck houses were changed, the fore-peak bulkhead was moved forward, and a bulkhead was added in hold number two, at the forward end of the bridge. But, since these alterations are not chargeable to the change in the system of construction, they have either been disregarded or their effect has been equalized.

Notwithstanding the necessity to make these departures from the working drawings, this opportunity for direct comparison offers very considerable advantages. Vessels of both designs have been built and are at the present time in actual operation, so that the case cannot be regarded as a hypothetical one. We have, further, the advantage of being able to obviate reduction to standard conditions, or, in the case of steel weights, to a basis of tons of deadweight capacity per ton of steel, since the vessels are of identically the same dimensions.

In this connection attention is called to the absence of side stringers in the transversely framed vessel, this omission having been compensated for by increased stiffness of side framing and greater thickness of shell plating. Since this simplification is now quite commonly adopted, both ships may be regarded as typical of the system of construction that they represent, but it should be borne in mind that the transverse framing construction has gone through a long course of development, while the Isherwood system is relatively very young and may consequently be regarded as being in a rather rapid state of evolution.

Comparison of Weights and Capacities

Rather careful calculations of the net steel necessary to complete the two vessels show that 2,023 tons were used for the transversely framed vessel and 1,881 tons for the Isherwood ship. These figures, which are in tons of 2,240 pounds, do not include scrap; that is, deductions have been made for lightening holes, notches in the plates where continuous members pass through, etc., and no allowance has been made for rivet heads or liners. The last two items should be very nearly the same for both types of ships, so that our comparison will not suffer from the omission of them.

The saving in net steel amounts, then, to 142 tons, or slightly over 7 percent, certainly a saving well worth while, provided it is not accompanied by a reduction in strength. This, however, does not represent the increase in cargo-carrying capacity, for the reduction in weight on the basis of the completed ship, including all machinery, equipment, etc., equals only about 4.65 percent, and the increase in the deadweight carrying capacity is about 1.9 percent. To the shipowner this last figure is the only one of any great significance, for, since it may be assumed that the custom-house measurements—that is to say, the taxes levied upon the vessel—are not affected by the change in the system of construction, the increase in the deadweight capacity equals the increase in the earning capacity in all cases where the weight, rather than the volume, is the important factor, unless, of course, the cost of operating the Isherwood vessel should rise because of the need of more frequent or more costly repairs.

The increase in the earning capacity is, in fact, the principal claim for favor made by the supporters of the Isherwood system, coupled, as it is, with the claim that the grain and bale capacities are also increased. The former contention is undoubtedly true, the improvement being due partly to the fact that the saving in steel means that a smaller volume is occupied by the framing, but mainly to the greater facility with which the inner bottom ceiling may be run out horizontally to the shell plating of the Isherwood ship, instead of being run up along the faces of the margin brackets, as is commonly done in transversely framed vessels. The bale capacity (i. e., the actual, "as loaded" bale capacity, not the calculated), on the other hand, is naturally somewhat impaired because the transverses break into the cargo holds at intervals that are but rarely a multiple of any of the three dimensions of the bales. In case of ordinary bale goods this may not be a serious matter, but in case an Isherwood ship were to carry lumber it would be necessary to load "short stuff" (that is, lath, shingles, or bundled flooring or ceiling), which means a mixed cargo where a straight cargo might be more easily obtainable, not to mention the greater stevedoring charges.

In this connection attention is called to the fact that practically all oil tankers are now being built to the Isherwod system, the principal reason being that this system lends itself more readily to the peculiar bulkhead and stiffening work necessary in that type of vessel, and only secondary to the saving in steel weight. The increase in the cubic capacity has, of course, no influence on the choice of system of framing for a tanker, since the deadweight capacity, not the cubic capacity, is the significant factor.

Longitudinal Bending Strength

As a criterion of the longitudinal bending strength, we might simply find and compare the section moduli of the two vessels. The matter was, however, gone into some-

* From a paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.

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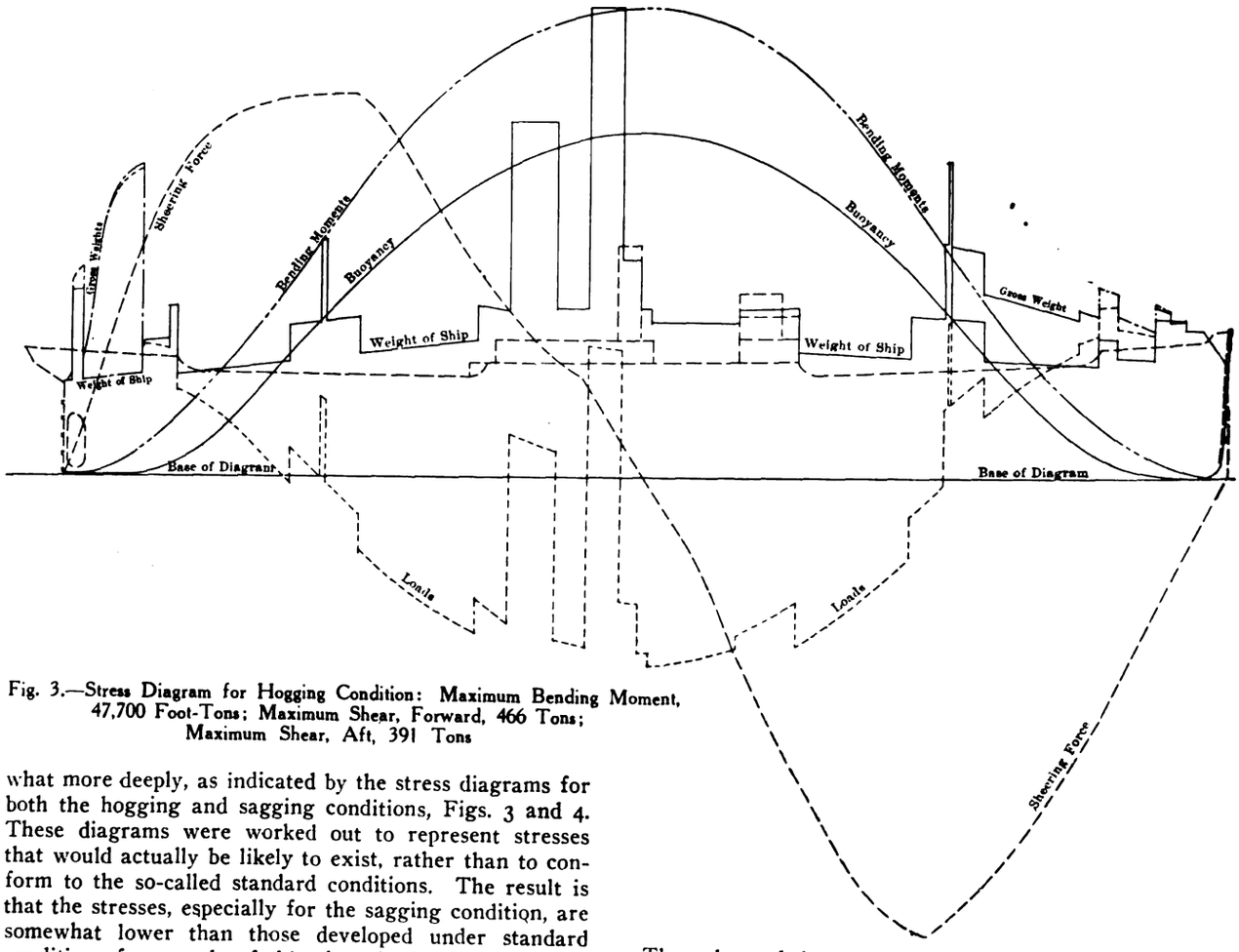

Fig. 3.—Stress Diagram for Hogging Condition: Maximum Bending Moment, 47,700 Foot-Tons; Maximum Shear, Forward, 466 Tons; Maximum Shear, Aft, 391 Tons

what more deeply, as indicated by the stress diagrams for both the hogging and sagging conditions, Figs. 3 and 4. These diagrams were worked out to represent stresses that would actually be likely to exist, rather than to conform to the so-called standard conditions. The result is that the stresses, especially for the sagging condition, are somewhat lower than those developed under standard conditions for vessels of this size, the bending moments being 41,200 foot-tons for hogging and 9,800 foot-tons for sagging.

Point of Maximum Bending Moment

It will be seen from the diagrams that the bending moment is maximum at about the middle of length for both the hogging and sagging conditions. But at this point the ship is strengthened by the long bridge, so that the point of most unfavorable combination of bending and resisting moments falls either just forward of the forward end of the bridge, or just abaft the after end of the bridge, at which points the section moduli may be taken as being equal, since the scantlings are the same at both points, only the sheer heights changing slightly. The section moduli were, in fact, calculated for the lowest point of sheer, and they may consequently be regarded as being somewhat conservative. On the other hand, in working out these section moduli an important departure from standard practice was made: the main rail and bulwark plating were included as strength members. The reason for this was that in the Isherwood ship the main rail and one of the bridge-space shell longitudinals form a practically continuous member. Since the shell longitudinal certainly is a strength member, there is good reason for including the main rail, and consequently also the bulwark plating, in the section modulus of the Isherwood ship, especially when these members are in tension. And if we decide in favor of the inclusion in the case of the Isherwood ship, the corresponding members must, of course, also be included in the section moduli of the transversely framed vessel, for the sake of retaining a fair basis of comparison.

The values of the section moduli, in inches to the third power, are:

	Hogging Condition	Sagging Condition
Transversely framed vessel.....	161,900	178,100
Isherwood vessel	170,300	189,700

In each case a deduction for seven diameter rivet spacing was made from the sectional area of the tension part of the section.

By applying the flexure formula, the unit stresses, in pounds per square inch, are now found to be:

	Hogging Condition	Sagging Condition
Transversely framed vessel.....	6,840	1,477
Isherwood vessel	6,500	1,392

It will be seen that the fiber stresses are, roughly, 5 percent less in the Isherwood vessel than in the transversely framed vessel.

This comparison holds good only, of course, when the vessel is in the upright position and the plane of bending is vertical, but it seems safe to conclude that an approximately similar relation of strength would be shown to exist were we to continue the analysis for various angles of inclination, and we may make the general deduction that in longitudinal bending strength an Isherwood ship is materially superior to a transversely framed vessel of the same dimensions.

Vertical Shearing Strength

A similar inference may be made for the vertical shearing strength. On the stress diagram for the hogging condition (Fig. 3) we find that the maximum vertical shearing stress is 466 tons, which is resisted by a cross-sectional area of 2,004.5 square inches for the transverse

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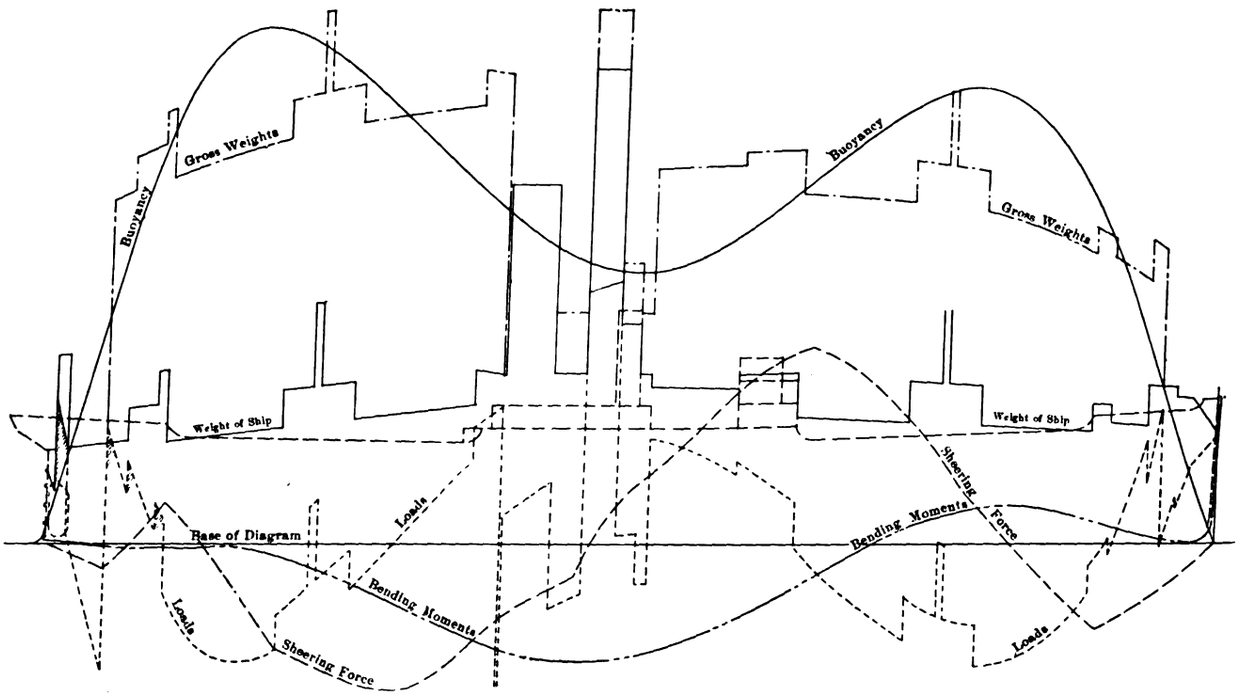

Fig. 4.—Stress Diagram for Sagging Condition: Maximum Bending Moment, 11,900 Foot-Tons; Maximum Shear, Forward, 198 Tons; Maximum Shear, Aft, 147 Tons

vessel and 2,252.7 square inches for the Isherwood vessel, giving unit shearing stresses of 520 and 468 pounds per square inch, respectively. While there is a material reduction in the unit stress in favor of the longitudinally framed vessel, this can scarcely be credited as an advantage for the Isherwood system, inasmuch as the stress values are too low for consideration.

Longitudinal Shearing Strength

Longitudinal or horizontal shear is usually found by the formula:

$$\text{Longitudinal shear} = \frac{VM_s}{tI},$$

where

V = vertical shear.
M_s = the statical moment of the section (= area × distance) between the plane at which it is desired to find the longitudinal shear and the extreme fibre, on one side of the plane of shear.
t = thickness of web at plane of shear.
I = the moment of inertia of the section.

In applying this formula to ordinary structural work, no consideration is given to transverse stiffeners or brackets, and, consequently, no careful investigation seems to have been made in this field. It is evident, however, that if the hull were to fail because of longitudinal shearing stresses, say along an edge lap in the shell at or near the neutral axis, the transverse framing would have to be sheared off along that edge lap. In the transversely framed ship we have transverse channel frames spaced 2 feet 2 inches, continuous from the bilge to the upper deck. These frames have a sectional area of 8 square inches each, but because of the elasticity of the riveting connecting the frames to the shell plating it would probably be unsafe to regard more than 50 percent of this area as effective in longitudinal shear.

At the edge lap between H and J strakes we have, then, per frame space, for one side of the ship:

	Square Inches
Gross shell plate area = 28 × .66	18.48
Less rivet holes, which for 4½ diameter spacing = 2/9 gross area	4.10
Net plate area	14.38
Effective frame area	4.00
Total area in shear	18.38

This corresponds to 8.47 square inches per foot length of ship for one side, or 16.94 square inches for both sides of the hull. The equivalent web thickness would then be 1.41 square inches.

In the Isherwood ship the case is quite different, however. We have, as before, the area of the shell plate, which amounts to 5.6 square inches per foot of ship, for one side, after deducting for the riveting. But to this area we cannot add the strength of a transverse frame. The angle connecting the transverse web frame to the shell is cut at every longitudinal, and the web plate itself is deeply notched, giving sufficient elasticity in the transverse members to make them useless in longitudinal shear. It is true that some frame rivets between the edge lap and the longitudinal would have to be sheared. If, in our case, we take the shell lap between H and G strakes as the plane of longitudinal shear, four or six rivets connecting the transverse clip to the shell between that lap and longitudinal number 16 would add to the longitudinal shearing strength. But with transverses spaced 12 feet apart, this becomes a negligible quantity and we can use the value found above, which gives an equivalent web thickness of 0.932 inch as effective in longitudinal shearing.

Using these values for t in the formula given above, 466 tons as the vertical or transverse shear and the proper respective values for the static moments and moments of inertia, we find that the longitudinal shear for the transverse vessel amounts to 2,570 pounds per square inch, and for the Isherwood vessel to 3,920 pounds per square inch, which shows an increase in fiber stress of over 50 percent. In either case the stress is small, however, and the reduction in strength should not be regarded as endangering the safety of the Isherwood vessel.

(To be concluded.)

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Buoyancy and Stability of Troop Transports*

Effectiveness of Watertight Subdiyisions—Loss of Stability—Ballasting—Longitudinal Bulkheads—The Case of the Empress of Ireland

BY PROFESSOR WILLIAM HOVGAARD

When a transverse bulkhead is divided into parts placed on different frames it is said to be stepped. Such a bulkhead actually consists of two or more vertical parts and one or more horizontal parts, or steps, the latter being formed by the deck or decks at which the continuity of the bulkhead is broken. Damage to the side by explosion or collision in way of a step located below the waterline is likely to open both of the adjacent compartments to the sea and thus, dependent on the length of the step, the value of the subdivision is seriously impaired. Suppose, for instance, that a bulkhead has a step 35 feet long and that the horizontal extent of the damage by an underwater explosion is likewise 35 feet; then the chance of both adjacent compartments being flooded by one explosion is practically doubled, due to the presence of the step.

Steps in bulkheads are therefore to be avoided or their lengths at least reduced to a minimum.

Recesses or horizontal steps in bulkheads are less objectionable, provided they do not extend so near to the sides of the ship as to be damaged by an underwater explosion.

Integrity of Bulkheads and Other Watertight Surfaces

Several precautions must be taken to insure the effectiveness of watertight subdivisions having for their main object to prevent the water from entering compartments other than those directly and unavoidably flooded by an accident.

In merchant vessels steps in bulkheads involve a danger in addition to that just explained, due to the fact that the frames almost invariably pass non-watertight through all decks below the bulkhead deck. When one of the compartments adjacent to a stepped bulkhead is flooded, and provided the step is situated below the waterline, water is liable to filter through the deck at the frames. The cement filling usually applied along the sides of the deck cannot be relied upon to keep tight under a considerable head of water. Thus the integrity of the stepped bulkhead is destroyed. The remedy is to fit stapling around the frame in that part of the deck which belongs to the bulkhead.

Recesses in bulkheads are not objectionable from this point of view, as they are usually watertight at the bounding decks.

The danger of fitting doors in the main transverse bulkheads of troop transports is enhanced by the difficulty of controlling the doors at all times. This may be due partly to the overcrowded condition liable to occur in troop transports, partly to the impossibility of obtaining a highly trained personnel for all such vessels under the stress of war. Great care should, therefore, be bestowed on this matter.

No doors should be allowed in main transverse bulkheads below the bulkhead deck, but this rule is not followed in passenger steamers. Doors are found partly on a low level, as between engine and boiler rooms, partly on a high level, notably on the deck just below the bulkhead deck. When such vessels are taken over for service as troop transports, all doors in transverse bulkheads on a low level in the engine and boiler rooms should be permanently closed. This, of course, will render communication and inspection more difficult, and many engineers for this reason strongly object to it. It is, however, a fact that in some of the largest American transports used during the war those doors were always closed when at sea without serious detriment to the service.

In most trans-oceanic passenger steamers the hold just forward of the boiler rooms is used as a reserve coal bunker. Often two compartments of the fore-hold are so used. Coal is drawn from the reserve bunkers through doors in the respective main bulkheads at the level of the fire room floor, and often a tunnel with a door at each end is fitted through the main transverse bunker, usually fitted in the forward end of the forward boiler room, so that coal may be drawn directly from the nearest reserve bunker. Such doors, putting two of the largest compartments in the ship in connection with each other, and being necessarily open during long periods while the ship is at sea, constitute a serious menace and should be closed under war conditions. This necessitates hoisting the coal from the reserve bunkers onto the bulkhead deck, whence it can be dumped into one of the regular bunkers, an arrangement which was adopted in several ships during the war.

The transverse main bunker bulkheads in passenger steamers are generally non-watertight with non-watertight sliding bunker doors and should be disregarded in considering the watertight subdivision; but even if such bulkheads are of watertight construction, it is best not to rely on them, since the doors will normally be open when the ship is under steam.

The following further recommendations are essentially an abstract of those given for large mail and passenger vessels under war conditions by a committee appointed by the Institution of Naval Architects in 1917 to inquire into the effects of underwater explosions on the structure of merchant ships.*

Firemen's passages should be permanently closed up and all openings from the engine rooms into shaft tunnels should be abolished, access to tunnels being provided through watertight trunks abaft the engine room bulkhead. If these recommendations are not carried out, the engine room tunnel doors should be quick-closing and capable of operation from the bulkhead deck or a deck above.

Doors fitted in main bulkheads on the 'tween deck below the bulkhead deck cannot always be dispensed with without great inconvenience to the service and without radical alterations. It is a fact, however, that such doors are very dangerous in cases where a ship takes a sudden and great list, whereby water is admitted to the 'tween decks and tends to spread forward and aft (*Empress of Ireland*). It is advisable, therefore, to close those doors, to secure them so that they cannot be opened, and to provide additional exits to the decks above where necessary.

The committee further recommended that all side scuttles situated below the first deck above the bulkhead deck be closed up and sealed. It may here be added that all side lights below the bulkhead deck should be not only closed

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919. Concluded from the January number.

* Report of May 8, 1917. Institution Naval Architects, 1918, p. xxxvii.

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but also protected by steel plates or strong watertight covers, as they are otherwise liable to be broken by the force of the underwater explosions.

Valves should be fitted on all sanitary discharges at the ship's side, such as will prevent water passing inboard through them when the vessel has a considerable trim or list.

The upper ends of ash or rubbish shoots, etc., opening on decks below the bulkhead deck should be provided with watertight covers, which should always be in place when the shoots are not in use.

Each suction pipe, where it enters the compartment from which it drains, should be provided with a screw-down, non-return or other suitable valve which can be worked from the bulkhead deck. These valves should be kept closed except when the pumps are in use.

Where ventilation trunks, etc., pass through watertight bulkheads below the bulkhead deck, valves operated from above that deck should, in all cases, be fitted at the bulkheads. No such trunks should be allowed to pierce the bulkheads at a low level.

The precautions here enumerated were carried out as far as practicable in the transports operated by the United States Navy in accordance with general orders to that effect issued by the Bureau of Construction and Repair. In the case of the *Mount Vernon* the blanking off of the side lights below the bulkhead decks proved of great value when the ship was torpedoed.

STABILITY

The stability of a troop transport should be such that under the above stipulated conditions of flooding there will remain a certain positive metacentric height, while the list, if any, must not be greater than that the boats can be lowered on both sides. In order to insure this result an investigation of the stability must be made. This presents no difficulty where information is at hand concerning the lines and the distribution of weights and where an inclining experiment has been made; but where such information is not available and where time is limited, approximate or crude methods must be adopted. We shall here describe the procedure followed by the Bureau of Construction and Repair during the war in such cases as occurred quite frequently when merchant vessels in an emergency were taken over by the Government and used as troop transports.

COMBINED INCLINING AND ROLLING EXPERIMENT

The first point to consider was the metacentric height under various conditions of loading when the ship is intact. A fair idea of the form of the hull was obtained by lifting offsets of the bottom while the ship was in dock, or, when this could not be done, by taking internal measurements. When practicable, an inclining experiment was made and at the same time the period of roll was determined. A combined inclining and rolling experiment gives the value of the coefficient K in the formula:

$$T = \frac{KB}{\sqrt{GM}},$$

where T is the time of a single swing in seconds, B is the beam, and GM the metacentric height, both in feet.

This formula affords a ready means of estimating the metacentric height at any time, even when at sea, by simply observing the period of roll.

Table II gives the results of such experiments for a few ships.

The *America*, during the experiment, was near her light condition, although she had 4,300 tons of coal and 1,450 tons of water on board. The *Mount Vernon* was on about the same draft as she would be carrying troops across the Atlantic when on her eastbound voyage and nearing European port; she had 4,650 tons of coal and 2,570 tons of water on board. The *Covington* was fully equipped, but, like the two other ships, without troops or cargo.

TABLE II—RESULTS OF COMBINED INCLINING AND ROLLING EXPERIMENTS

Ship	Displacement at time of experiment T	G	T	K	D
	Tons	*Feet*	*Sec.*		*Feet Inches*
America, ex Amerika	27,500	1.4	14.0	0.220	27 6
Mount Vernon, ex Kronprinzessin Cecilie	27,250	2.5	10.2	0.223	30 9
Covington, ex Cincinnati	22,000	2.5	9.15	0.221	28 9

VARIOUS CONDITIONS OF LOADING

A careful investigation was made of the probable loading of the ships under various conditions, and the corresponding draft and trim were calculated. In particular, the following conditions were studied:

1. When a transport sails from the port of embarkation, fully equipped, with troops and cargo on board.
2. When she arrives at the port of debarkation.
3. When she sails from that port.
4. When she returns to the port of embarkation.

For each of these conditions the position of the center of gravity and the metacentric height were calculated, or, where no inclining experiment was available, the position of the center of gravity was determined by an approximate calculation.

THE PERIOD OF ROLL AT SEA

In all cases, whether an inclining experiment was made or not, the period of roll was observed later when at sea in the various conditions of loading. As far as possible the observations were taken under circumstances when the rolling was of a fairly regular character and small or moderate in amplitude. By comparison with other ships of similar size and type, for which K was known, this coefficient was estimated for each vessel and the metacentric height calculated approximately. The following table gives the observed period of roll and the mean draft for a number of typical ships in full-load and light conditions, that is, at the beginning and end of the round trip:

TABLE III—PERIODS OF ROLL AT SEA

Ship	After leaving U. S. Full Load		[Before arriving U. S. Light	
	D	T	D	T
	Feet Inches	*Seconds*	*Feet Inches*	*Seconds*
Leviathan, ex Vaterland	40 11	11.0	36 8	13.0
George Washington	35 0	8.0	28 5	11.0
Mount Vernon, ex Kronprinzessin Cecilie	34 6	9.0	26 0	11.0
President Lincoln	32 7	8.7	24 3	6.7
Covington, ex Cincinnati	30 9	8.1	24 6	9.9
Louisville, ex St. Louis	30 4	7.7	27 9	8.2
Aeolus, ex. Grosser Kurfurst	26 11	6.5	22 9	9.0
Pocahontas, ex Prinzessin Irene	26 9	6.0	23 3	7.5
Great Northern	26 8	7.4	21 8	7.8
Calamares	24 4	9.0	19 6	11.3
Orizaba	24 0	7.0	18 3	11.0

THE LOSS OF STABILITY BY BILGING AND THE RESIDUAL METACENTRIC HEIGHT

The effects of bilging on stability may be studied by calculating the change in metacentric height and the angle of heel by approximate methods. In ships subdivided on the purely transverse system it is sufficient to determine the change in metacentric height, assuming that two or

* President Lincoln, in the light condition, carried 2,400 tons of steel ballast, 2,200 tons of water and 1,700 tons of coal.

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three of the largest compartments are flooded, according as the ship is required to come up to the two- or three-compartment standard respectively. In order to obtain the severest case, it may be necessary to repeat the calculation for several combinations of flooded compartments. Using the lost buoyancy method, by which the center of gravity remains fixed in position, the change in metacentric height, MM_1, is the algebraic sum of the vertical movement of the center of buoyancy, BB_1, which is always positive, and the change in metacentric radius, which is always negative and approximately equal to $\frac{si}{V}$, where i is the moment of inertia of the free surface of water in the flooded compartment, s is a factor of permeability, and V is the volume of displacement of the ship. We have, therefore, in a transversely subdivided ship

$$MM_1 = BB_1 - \frac{si}{V}.$$

When a ship is in the light condition, BB_1 is relatively small, because the water does not rise to a great height inside the ship, but $\frac{si}{V}$, which represents the effect of the free surface of water in the compartment, will have approximately its full value. The loss in metacentric height is, therefore, a maximum and, hence, the ship is in this condition most liable to take a great list. In the full-load condition, on the other hand, BB_1 is very great, while $\frac{si}{V}$ has about the same value as in the light condition, so that MM_1 is either negative and relatively small or, in some cases, even positive. Hence, after flooding, the metacentric height in the full-load condition is practically the same as when the ship is intact, and, provided there are no longitudinal bulkheads, the ship will remain upright with ample stiffness; but, as shown above, in this condition the danger of foundering by bodily sinkage or of going down by the bow or stern is at its maximum.

Calculations made for a great number of transports showed that the loss in metacentric height by flooding two of the largest compartments in two-compartment ships when in the light condition varied from 1 to 2 feet, being ordinarily about 1½ feet. In most vessels flooding of the forward boiler room, together with the adjoining forehold—generally used as a reserve bunker—gave the greatest loss in stability.

Having calculated the probable loss in metacentric height in a given ship, it remains to estimate what the residual metacentric height ought to be after bilging, whereupon the appropriate value of this element in the intact condition can be determined. Evidently the residual metacentric height must be estimated with due regard to the size of the ship and her liability to take a list.

Ships that are subdivided on the purely transverse system will remain upright so long as there is any stability left and no external forces tend to heel them over. They will be safe, therefore, with a very small metacentric height, say from ½ foot in vessels of about 500 feet in length to about 1 foot in vessels of the largest size. Assuming a loss by bilging of 1½ feet, the initial metacentric height should therefore be not less than from 2 to 2½ feet in the light condition while the ship is yet intact.

If the calculated loss is found to be greater, these figures must be correspondingly increased. This claim being satisfied in the light condition, there will generally be ample stability in the full-load condition.

Ships with longitudinal bulkheads, whether watertight or not, should have a greater residual metacentric height in damaged condition than required for ships with only transverse bulkheads. The residual metacentric height should be so calculated that under the stipulated conditions of damage the list shall not prevent the lowering of the boats on both sides of the ship, that is, the list should probably not be greater than from 5 to 10 degrees. It must be borne in mind, however, that when holes are provided in the longitudinal bulkheads, as recommended above, a rapid equalization will take place immediately after the accident and the list may be expected to decrease very fast during the first few minutes, unless other causes tending to increase it intervene. It seems reasonable, therefore, in estimating the residual metacentric height, to allow a somewhat greater angle of heel, depending on the nature of the longitudinal subdivision. Assuming a permissible initial list of from 10 to 15 degrees, it is found that the residual metacentric height should probably be not less than from 1½ feet in transports of about 500 feet in length to 2½ feet in transports of the largest size. This gives a metacentric height in the light intact condition of from 3 to 4 feet, but these figures must be regarded only as average values.

In the full-load condition the freeboard, and hence the range of stability, is a minimum; but, on the other hand, the metacentric height is likely to be greatest and does not in general suffer so much reduction by bilging. Again, if the stability is sufficient in the light condition it will generally be sufficient when the ship is fully loaded, but probably the metacentric height should not be less than from about 4½ feet in smaller transports to 5½ feet in transports of the largest size in the intact full-load condition. Here, as when in the light condition, each ship must be dealt with independently and on its own merits.

As might be expected, these requirements are not fulfilled in ordinary passenger steamers as operated under peace conditions. The *Empress of Ireland* had a metacentric height of 3½ feet when the collision occurred, at which time she was practically in the full-load condition. This was reduced to 2¾ feet* by flooding of the boiler rooms. In the troop transport of the same size the metacentric height should be about 1 foot greater. Had doors and side lights been closed on the main deck and had holes been provided in the side-bunker bulkheads, the list would soon have been reduced by equalization to less than 10 degrees, in which case the ship would probably have remained afloat and boats could have been lowered on both sides.

The *George Washington*, which has no longitudinal subdivision, satisfies practically the above requirements, having a metacentric height of 2½ feet in the light condition and 4½ feet in the full-load condition, but in the *Leviathan* these figures are 3 feet and 4 feet, and in the *Mount Vernon* 2.1 feet and 3.2 feet respectively, showing that these vessels, which have many longitudinal bulkheads, fell short of the requirements.

BALLASTING

In order to secure the metacentric heights specifi above, most passenger steamers used as troop transports must carry some ballast, at least when they are in the light condition. Ocean-going passenger steamers are in general designed with rather small stiffness. According to the best practice they are in the lightest condition, given almost zero stability, that is, a very small positive meta-

* According to the lost buoyancy method.

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centric height, in which case they may be expected to have a metacentric height in the loaded condition sufficient for safety under peace conditions, and yet so small as to give easy movements in a seaway.* German designers of such vessels have gone further in direction of reducing the stability,† and most of the ex-German ships used as troop transports during the war have a negative metacentric height in the light condition unless they are given a considerable amount of ballast.

Ballast may be solid or liquid. Solid ballast usually consists of pig-iron, scrap-iron, cement, gravel or sand, and if permanently on board the ship is referred to as "fixed" ballast. Liquid ballast ordinarily consists of water, fresh or salt. The quantity of ballast should be determined by a careful calculation, so as to secure the desired metacentric height under various conditions of loading, but when a ship is taken over in an emergency for immediate use there is no time for elaborate calculations, and the amount of ballast required must be estimated preliminarily, based on the behavior of the ship in commercial service and on a comparison with other ships. Later, when experience has been gained at sea, the ballast may be adjusted more accurately, and here the period of roll affords a valuable guide. This procedure was followed in most of the ex-German ships used as troop transports.

On the whole, water ballast is preferable to solid ballast, since it can be more readily taken on board and again discharged when not needed, and does not in general occupy useful space in the hold. Solid ballast, therefore, should not be used except when the tanks available for water ballast are of insufficient capacity for this purpose. In many ships, however, the amount of ballast required in the light condition is much greater than it is possible or practicable to carry in the tanks, and it becomes necessary, in order to avoid shipping or unshipping of ballast on each voyage, to carry permanently a considerable weight of solid ballast, which in the full-load condition is a useless deadweight. One reason why tanks of sufficient capacity may not be available for the purpose of ballasting, even where the tank space is very large, is that when the troops are on board most of the tanks are used for fresh water, and it may not be possible at the port of debarkation to obtain fresh water in sufficient quantity or of satisfactory quality. There is then no choice but either to leave the tanks empty on the return voyage or to fill them with salt water; but the latter course is clearly objectionable, as it necessitates washing out of the tanks at the port of debarkation, for which operation there may be no time or opportunity. Hence it is often preferred to leave most of the tanks empty on the return voyage and to carry fixed ballast instead.

The need of fixed ballast would, of course, disappear if the ships were designed so as to have sufficient stiffness under all conditions, and this solution is to be preferred in vessels designed and built exclusively for troop transport, where safety under war conditions is the first consideration. In passenger steamers, designed for service in peace time, comfort is of prime importance, the stability must necessarily be small, and ballasting under certain conditions may become a necessity.

Table IV on this page gives the weight of fixed ballast carried by some of the troop transports during the war, and also the amount of water carried when the ships in the light condition were near the end of their voyage.

TABLE IV—BALLASTING OF TROOP TRANSPORTS

Ship	Fixed ballast	Water, fresh and salt
	Tons	*Tons*
Leviathan	820	5020
George Washington	921	2290
President Lincoln	2400	2200
Aeolus	1300	1670
Pocahontas	1300	1370

LONGITUDINAL BULKHEADS

Most merchant vessels are subdivided on the purely transverse system. When damaged under water they usually preserve their upright position or take a slight list, and if they founder they go down by bodily sinkage, bow or stern first. The boats can be lowered without difficulty, provided the sea is not too rough, and in well-subdivided ships ample time will be generally left for this operation (*Titanic*). At the International Conference on Safety of Life at Sea in London, 1913, "evidence was produced which made it perfectly clear that there was no known case of a vessel having been bilged in service and them capsizing. . . . ."*

Longitudinal watertight bunker bulkheads commenced to be introduced in merchant vessels with the *Lusitania*—primarily in order to secure coal protection against gunfire—and were subsequently fitted in certain other English liners destined to be used as auxiliary cruisers in time of war. In Germany such bulkheads were fitted in several vessels, as in the *Kronprinzessin Cecilie*, her sister-ship *Kaiser Wilhelm II* and the *Vaterland*, later used during the war as troop transports by the United States Government and re-named the *Mount Vernon*, *Agamemnon* and *Leviathan* respectively. In these vessels centerline bulkheads, moreover, were fitted in the engine rooms.

In other passenger steamers, as, for instance, the S. S. *Philadelphia*, used as a troop transport under the name of *Harrisburg*, side bunkers are fitted which are virtually independent of each other, since they can only equalize across the top of the boiler room on a level well above the deep-load waterline.

Side bunker bulkheads, whether watertight or not, always constitute a danger to stability in merchant vessels where adequate means of quickly correcting a list are not available. An underwater explosion on one side may cause a bunker on that side to be flooded immediately and, generally, also the adjoining boiler room. The opposite bunker will not, as a rule, be flooded so quickly, even if the bunker doors are non-watertight and open, because usually the doors are choked with coal and the water can enter but slowly. The ship, therefore, at once takes a list, and, although a gradual equalization may take place, water is likely at the same time to filter into adjacent compartments or spread over 'tween decks, so that the stability may be destroyed and the ship capsize before equalization in the bunkers can prevent it. In such a case, then, the loss of the ship is directly due, not to the longitudinal bulkhead on the damaged side, but to the intact bulkhead on the other side, and the danger is greater the more watertight that bulkhead is. In point of safety, side bunkers are useful only provided they are narrow, well subdivided and watertight, and then only in cases of minor damage, where the side bulkhead remains intact. It is best, therefore, to avoid all such bulkheads in merchant vessels.

The danger of side bunkers in passenger vessels became evident by the loss of the *Lusitania* on May 7, 1915. The *Lusitania* was going at about 18 knots speed when she was hit almost simultaneously by two torpedoes on the starboard side abreast of the boiler rooms. One of the torpedoes hit near the bulkhead separating boiler rooms 1 and 2. Lifeboat No. 5, which is about 160 feet aft of that

* L. Peskitt, Institution of Naval Architects, 1914, p. 191.
† P. Driessen, *Schiffbau*, 1909, p. 269.

* Sir A. Denny, Institution of Naval Architects, 1914, p. 204.

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bulkhead, was destroyed by the blast of an explosion, but whether from the same or the other torpedo is unknown. The ship at once took a list of about 15 degrees, undoubtedly due to the presence of the side bunkers, and this list gradually and rapidly increased, due to infiltration of the water, especially through open sidelights. At the same time the bow was sinking deeper into the water than the stern. In less than twenty minutes after the explosion the ship capsized and sank. The initial list was so great that it was practically impossible to lower the boats on the port side, although the sea was calm. Due to this fact and the short time available before the ship went down, about 1,200 lives were lost out of a total of about 1,950 persons on board the ship.

Centerline bulkheads are no less objectionable and dangerous in merchant vessels than in warships. A calculation shows that in the *Leviathan* flooding of the two engine rooms on one side will produce a list of 19 degrees, and in the *Mount Vernon* of 21 degrees, while in the *George Washington*, where there is no centerline bulkhead, flooding of the main engine room will leave the ship upright, the sole effect being a sinkage of about 2½ feet, with a total change of trim by the stern of about 5 feet.

A more insidious source of danger is found in many merchant steamers—even such as are ostensibly subdivided on the transverse system—due to the existence of "shifting bulkheads" fitted longitudinally inside transverse bunkers, usually at or near the centerline and often on top of a tunnel. These bulkheads, which are fitted for the purpose of preventing the coal from shifting, are non-watertight and are in some ships provided with holes, which in case of bilging permit an equalization of the water from one side to the other. Ordinarily, however, the water must rise to a considerable height on one side before it begins to equalize, especially where the bulkhead is fitted over a tunnel and the holes are at a high level. Often the flow is very sluggish, because the openings are choked by coal. Thus, shifting bulkheads temporarily, at least, have the same effect as watertight longitudinal bulkheads.

A striking proof of the dangers of such quasi-longitudinal subdivision is furnished by the loss of S. S. *Empress of Ireland* in May, 1914, as the result of a collision with the S. S. *Storstad*. The *Empress of Ireland* had two large boiler rooms, each with a cross bunker at either end connected by side bunkers. All the bunker bulkheads were non-watertight. Water could flow freely from the side bunkers into the adjacent cross bunkers, but at the centerline in these latter were longitudinal passages and shifting bulkheads, which, although provided with holes, greatly retarded the equalization of water from one side to the other inside the bunkers (see Fig. 2). The ship was otherwise subdivided on the transverse system. At the time of the collision the bunkers were practically full of coal.

The *Storstad* struck the *Empress of Ireland* almost at right angles on the starboard side in way of bulkhead No. 5, which separates the two boiler rooms from each other. A breach was produced in the side of the *Empress of Ireland* of an area below the waterline, estimated to be not less than 350 square feet—about the same size of hole as would be produced by the explosion of a torpedo. The immediate effect of the damage was that the watertightness of bulkhead No. 5 was destroyed and that both boiler rooms were put in communication with the sea. Flooding of these compartments involved a mean sinkage of practically 9 feet, which took the main deck 4 feet below the water at the centerline amidships. At the same time the ship took a heavy list.

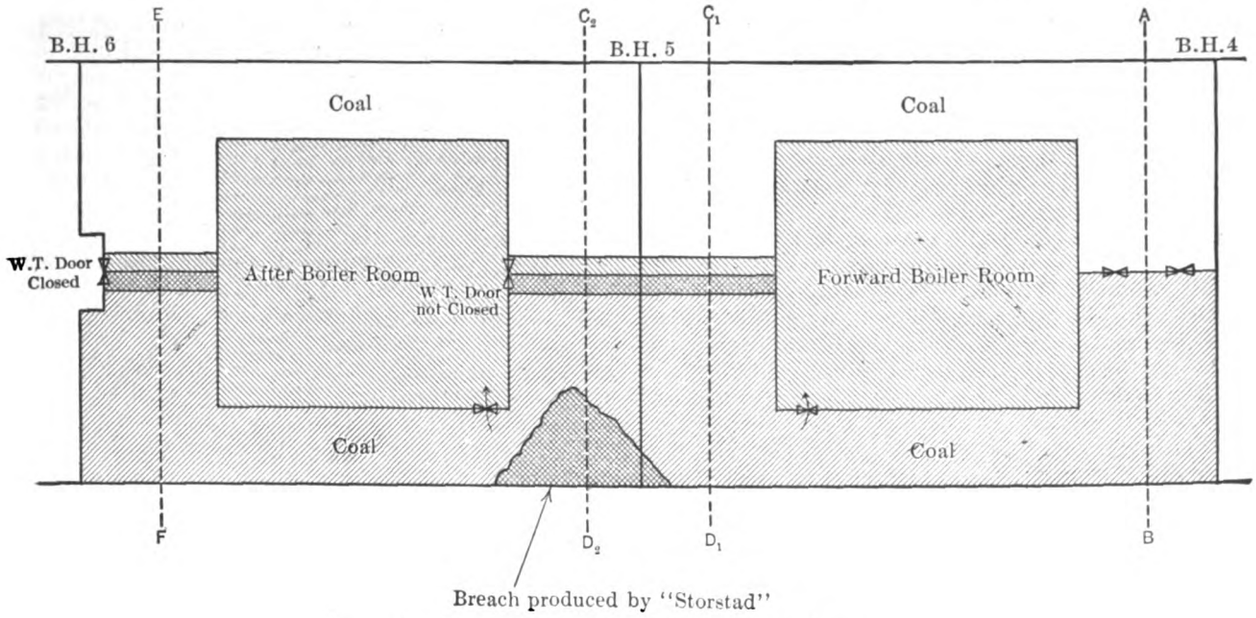

Fig. 2.—*Empress of Ireland;* Plan of Boiler Rooms

Quoting from the Parliamentary Report, p. 17: "There is no evidence that the *Storstad* destroyed any portion of the bunker bulkheads, so that very shortly after the impact a large quantity of water must have entered the bunkers on the starboard side for the whole length of the boiler rooms, which water was able to escape only through bunker doors in the boiler rooms and relatively slowly also across the middle-line partitions in coal bunkers to the port side of the vessel. Under these circumstances the ship would at once commence to list to starboard * * * making reasonable approximations, an inclination of some 15 to 20 degrees appears probable. * * * From such a list the vessel might have recovered as the water got to the port side, if all port holes and all watertight doors in bulkheads bounding the boiler compartments up to the upper deck had been closed, but with doors and side lights open

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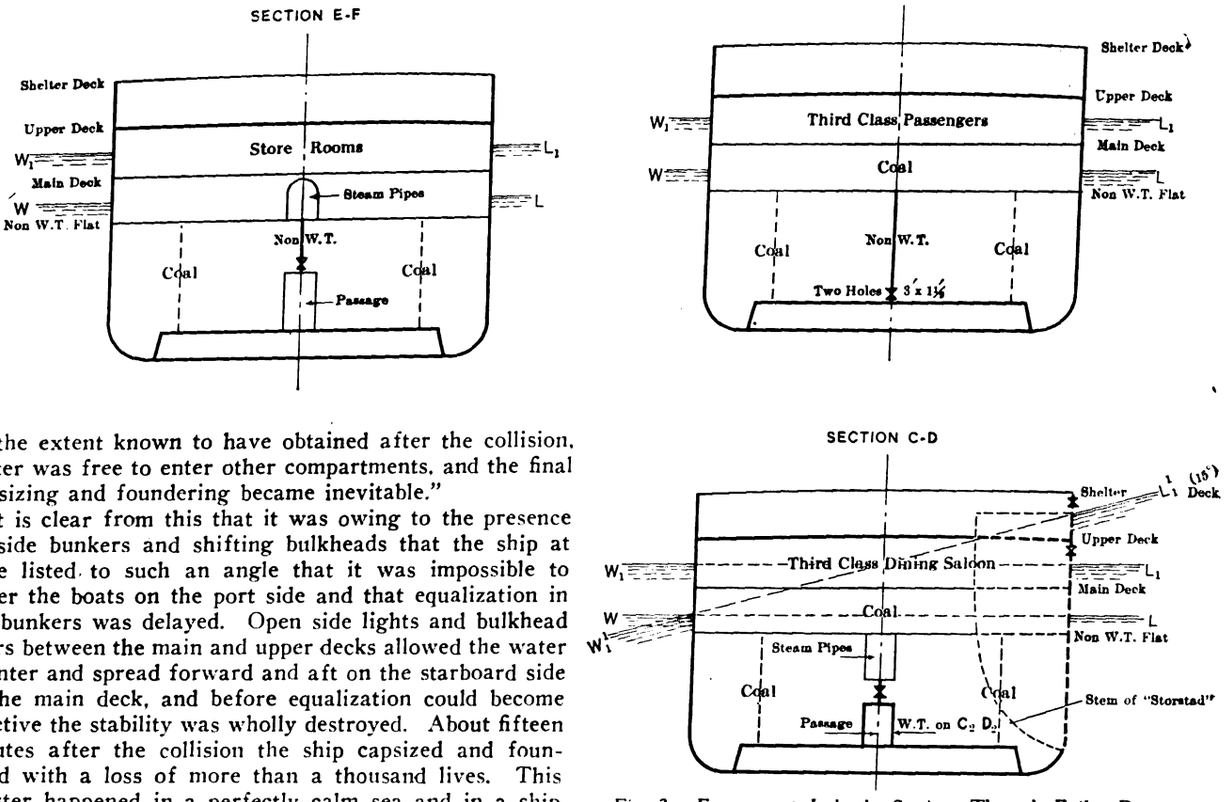

Fig. 3.—*Empress of Ireland;* Sections Through Boiler Rooms

to the extent known to have obtained after the collision, water was free to enter other compartments, and the final capsizing and foundering became inevitable."

It is clear from this that it was owing to the presence of side bunkers and shifting bulkheads that the ship at once listed to such an angle that it was impossible to lower the boats on the port side and that equalization in the bunkers was delayed. Open side lights and bulkhead doors between the main and upper decks allowed the water to enter and spread forward and aft on the starboard side of the main deck, and before equalization could become effective the stability was wholly destroyed. About fifteen minutes after the collision the ship capsized and foundered with a loss of more than a thousand lives. This disaster happened in a perfectly calm sea and in a ship which was generally considered well designed and safe.

Longitudinal shifting bulkheads are fitted also in the cargo holds of all merchant vessels which carry cargoes that are liable to shift, but are in such case ordinarily provided with large door openings at the foot, and under the cargo hatches portable wooden partitions take their place, allowing a fairly free equalization of the water in case of bilging.

The obvious remedy against the ill effects of longitudinal subdivision is in all cases the same—to destroy the integrity of the longitudinal bulkheads by cutting permanent openings of ample size in them at the lowest possible level. In centerline bulkheads in engine rooms it will generally be sufficient to remove existing doors or to secure the doors in the open position, so that they shall never be closed while the ship is at sea. If, however, the doors are of small area or placed at a high level, permanent openings should be cut at the foot of the bulkheads. Prof. C. Pagel, Director of the Germanischer Lloyd Classification Society, in 1916,* speaking of the danger of centerline bulkheads, made the following statement: "Hence, for those of our (the German) passenger steamers that are provided with a centerline bulkhead in the engine room, it is prescribed that in such a bulkhead great doors shall be fitted, which must be open during the voyage, so that, in case of bilging, water can flow to the endangered side and thus a great list be avoided." In the shifting bulkheads of transverse bunkers, similar holes should be cut of sufficient size to allow for the obstruction to the flow of the water caused by the coal. Where tunnels extend to a great height above the floor of the bunkers and are surmounted by shifting bulkheads, holes cannot be cut at a low level, and it may here be necessary to fit equalizing pipes or ducts under the tunnels. In side bunker bulkheads holes of ample size should likewise be cut, and, in order to prevent the coal from running out, they should be provided with grating or wire mesh. The precautions here described serving to annul or reduce the heeling effect of longitudinal subdivision were taken by the Bureau of Construction and Repair as needed in all the troop transports under the control of the United States Navy during the war.

* Jahrb. Schiffb. Ges., 1916, p. 142.

Lloyd's Shipbuilding Returns

THE returns compiled by Lloyd's Register of Shipping, which only take into account vessels of 100 tons and upwards, the construction of which has actually commenced, show that there were 757 merchant vessels of 2,994,249 gross tons under construction in the United Kingdom at the close of the quarter ended December 31, 1919. Of these vessels, 616 of 2,395,412 tons are under the inspection of the surveyors of Lloyd's Register with a view of classification by that society.

As compared with last year, when only 1,979,952 gross tons of merchant shipping were under construction in the United Kingdom, the present figures show an advance of over a million tons in the twelve months. The leading district in the United Kingdom is the Clyde, where 155 vessels of 683,940 gross tons are under construction, but the district which has shown the greatest increase for the last quarter is the Tyne, where 114 vessels aggregating 593,189 gross tons are under construction, an increase for the quarter of 10.5 percent.

Outside of the United Kingdom the volume of merchant shipping under construction amounts to 4,867,114 gross tons, of which the United States is building 2,966,515, or less than the total now under construction in the United Kingdom. France shows an increase of 42,000 tons and Holland 40,000 tons. The figures for the whole world are 7,861,363 gross tons, about 60 percent of this being built under the supervision of Lloyd's surveyors with a view to classification by that society.

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Superheated Steam and Operating Costs

BY H. B. OATLEY*

The fact that marine engineers abroad have come to the use of superheated steam is evidenced by the many ships contracted for and laid down since the armistice in which superheat has been specified. Further evidence is shown in the reports of new construction made public in the technical press. The rapid strides being made in England and on the Continent will be better appreciated by referring to the table published in connection with this article, which, while incomplete, is impressive. It should serve to focus the attention of American shipowners and shipbuilders more than ever before upon the necessity of putting American ships on an equal basis with foreign tonnage, so far as the economics in fuel obtainable through these means is concerned.

THE thought now being given by engineers in this country to the use of superheated steam is not only timely, but it is a compelling necessity, now that we are embarked upon a merchant marine programme that involves the factor of competition. A still more encouraging sign is the action of some of the progressive shipbuilders in this country who are now laying down vessels for their own account or for American owners. Having realized the limitations of vessels constructed during the war, they have decided to eliminate unfavorable equipment and employ those which will contribute towards a reduction in operating expenses. This idea was expressed by an official of one of the leading shipyards in the United States when he wrote:

"The vessels are to be constructed for our own account, and it is our desire that in every respect the power plant shall be the best which can be produced."

It is a problem which needs the prompt and energetic action of our shipbuilders, and if such action is taken we may confidently expect that American shipyards will step into the first rank in building ships for most effective operation. The use of superheated steam will become better and more favorably known in the United States and Canada as this interest takes form in an investigation of these foreign ships which are successfully making use of it at the present time.

That superheated steam is receiving more consideration than formerly will be evidenced by Rear Admiral C. W. Dyson's paper in the August *Journal of the American Society of Naval Engineers*. He says: "The advantages derived is of such great amount as to be worthy of the most serious consideration." Table II (above the dotted line) is arranged from the data given in his paper; below the dotted line the figures are taken from the curves showing water per shaft horsepower (see Fig. 1 in his paper).

TABLE I

	No. of Ships	Type of Ship	Type of Engines	Horsepower (Each)	Degree Superheat
For British or British Colonial Ownership	3	Tankers	Triple	2500	200
	3	(*)	Gear Turb.	1500	150
	1	Cargo	" "	3000	100
	2	"	Triple	2500	200
	2	"	Gear Turb.	5000	200
	2	"	Triple	2600	200
	3	Pass. & Cargo.	Gear Turb.	13500	200
	4	" "		1400	200
	3		Gear. Turb.	3500	200
	2	Pass. & Cargo.		4500	120
	2	" "		4500	200
	1	" "	Gear Turb.	6000	150
	10	Passenger	" "	13500	200
	12	Tankers	" "	1500	200
	2	Pass. & Cargo.	" "	3000	150
	2	" "	" "	3500	150
	2	" "	" "	4500	150
	1	" "	" "	6500	150
	1	" "	" "	5000	150
	1	Cargo	" "	5000	150
	5	Refrigerator	" "	4250	150
	3	Cargo	" "	3000	200
	3		" "	3500	200
	2		" "	5000	200
	1	Pass. & Cargo.	" "	6000	200
	1	" "	" "	5000	200
	2	" "	" "	8000	200
	1		Quadruple	4000	200
	1			2500	100
	1	Pass. & Cargo.	Gear Turb.	14000	150
	1	" "	" "	5000	200
	1	" "	" "	4500	200
	1	Cargo	" "	3000	150
	4	"	" "	2000	120
	4	Pass. & Cargo.	Gear Turb.	5000	200
For French Ownership	3	Pass. & Cargo.		4000	275
	2	Cargo	Gear Turb.	2500	280
	2	"	" "	5000	200
For Danish Ownership	12	Cargo	Recip.	750	200
For Holland Ownership	12	Pass. & Cargo.	Gear Turb.	3500	150
	1	" "	Triple	4500	200
	1		Gear Turb.	3500	200
For Norwegian Ownership	2	Cargo	Triple	3500	200
For Italian Ownership	1	Passenger	Gear Turb.	20000	200
For Swedish Ownership	2	Cargo	Triple	3000	200
	130			572050	

* Converted sailing ships.

TABLE II

Percent Engine Power	Degree of Superheat	Steam Saving	Saving Per Degree
		Percent	Percent
30	41	6.7	0.163
50	46.3	7.0	0.151
100	58.6	8.0	0.136
....	.....	.....	.....
110	60.5	8.98	0.146
120	62.0	9.43	0.153
130	63.3	11.00	0.176
140	64.0	11.55(Est.)	0.184 (Est.)

The figures for rates above 100 percent are to be noted particularly, as a reading of the paper might lead to the conclusion that there was a steady decrease in the saving per degree of superheat. At the higher rates of engine power the *saving per degree increases*, although the degree of superheat is not increased to a marked extent. The increased saving at the higher rates of power, which is characteristic in superheated steam operation, is one of the excellent reasons why highly superheated steam is in such common use in the merchant marines the world over and explains its rapid increase in popularity evidenced by more than 2,000 vessels in operation or building.

In Fig. 1 there is reproduced curves *A* and *B* from Admiral Dyson's paper, and also curves from two locomotives tested under complete and accurate conditions. It will be of interest to note the characteristics of both sets of curves. It will also be interesting to note the remarkably low steam rates obtained by using high degrees of superheat and to see how closely they approach good marine practice. This feature is remarkable when consideration is given to the fact that a simple non-condensing engine is being compared with a triple-expansion condensing plant.

* Chief engineer, Locomotive Superheater Company, New York.

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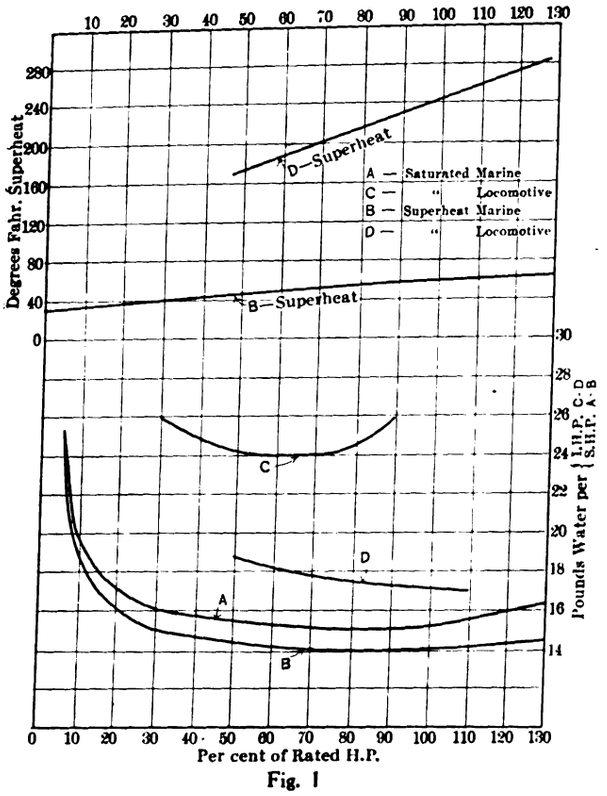

Fig. 1

It is self-evident that a higher degree of superheat in marine practice would produce economies in both steam and fuel. It is reported that the Navy Department is planning to use higher degrees of superheat on new construction, and in this respect is adopting the practice being followed in other navies.

The paper by Admiral Dyson also states that the "average rough figure for the gain due to superheating may be taken as one percent gain for every ten degrees of superheat." The inference is that this has reference to the fuel economy and not to the steam economy. At any event, every 10 degrees of superheat may, with triple-expansion engines, be safely counted upon to produce one percent saving in fuel, providing that the superheater is correctly designed, installed and operated.

In Admiral Dyson's paper stress is laid on the steam saving, and little is said relative to the fuel economies obtained on the naval vessels which he has analyzed. While fuel economy in naval practice is of great importance, it figures less from a financial standpoint than in merchant service.

The fuel economy on merchant ships resulting from superheated steam operation is generally acknowledged, but its importance will justify repetition. In Table III is given the fuel used per hundred deadweight ton miles for a number of ships, the logs of which are available and should be food for thought by shipowners. These data have been collected from ships of varying sizes, having several different methods of propulsion and using saturated steam as well as different degrees of superheat.

While different forms of hull, and class of vessel, will

TABLE III

NAME OF VESSEL	Deadweight Tonnage	Type of Engines	Superheat in Degrees F.	Coal (in pounds) per 100 Deadweight Ton-miles.			Horsepower, Shaft or Indicated
				Saturated Steam	Up to 150 degrees Superheat	Over 150 degrees	
Tellus	2600	Tr. Ex.	200			3.26	650
Adonis	2840	" "	175			4.25	700
Manta	3470	" "	None	5.15			
Kaskaskia	3900	" "	"	5.79			
Arcturus	4600	Elec.	200			2.46	
Elinor	4600	Turb.	50		6.76		
Griqua	5700	Tr. Ex.	200			3.56	1500
Canadian Voyageur	6000	" "	None	4.10			
Moreni	6750	" "	200			2.80	
Port Phillip	6780	" "	None	4.92			
Port Augusta	6800	" "	200			3.67	2150
Shimosa	7000	" "	None	5.25			
Dennis	7200	" "	"	4.32			
Stephen	7400	" "	200			3.15	2000
Bear	7500	" "	None	5.72			
El Rio	7500	" "	"	4.38			
Ferrona	7650	" "	200			2.96	1925
Malden	8550	" "	None	4.90			
Harben Maru	8600	" "	200			3.14	
Alban	8700	" "	200			3.36	2500
Eastern Sun	8800	" "	150		3.80		
West Cape	8800	" "	None	6.24			3000
Phidias	9400	" "	200			3.10	3000
Oswald	9500	" "	200			2.97	2500
U. S. S. Thomas	9650	" "	None	5.85			
Melania	9720	" "	200			2.80	2400
Pearl Shell	9750	" "	200			2.88	2400
City of Corinth	9800	" "	200			3.13	2585
Oswego	9800	" "	200			3.17	
Nias	9870	" "	200			3.22	2300
Bolton Castle	10000	" "	200			3.07	2700
Batjan	10400	" "	200			3.37	3000
Kathlamba	10500	" "	200			3.03	2900
City of Canton	10600	Turb.	150		3.94		
Lepanto	10600	Tr. Ex.	200			3.03	2500
Saratoga	10600	" "	None	6.35			
Eastern Light	10700	" "	"	4.87			
Kandahar	10800	" "	200			2.99	3150
Appeles	11000	" "	200			3.02	4000
City of Newcastle	11000	" "	50		4.20		
Ohioan	11000	Quad.	None	4.42			
Tsuyama Maru	11000	Tr. Ex.	200			2.88	
Madioen	11300	" "	200			3.78	3500
Keelung	11200	" "	200			2.98	3350
Leitrim	11700	2-Turb.	125		3.72		5000
Tokuyama Maru	11700	2 Tr. Ex.	200			2.50	3500
Toyohashi Maru	11700	2 " "	200			2.75	3500
Defiance	11800	Turb.	20		4.37		3000
Finland	11925	Tr. Ex.	None	6.95			
Tobe Maru	12000	2-Tr. Ex.	200			2.81	3000
Radja	12500	Tr. Ex.	200			3.19	
Armagh	15000	2-Turb.	125		3.71		10000
Hawaii Maru	15800	2-Tr. Ex.	175			2.64	
			Average	5.28	4.36	3.10	

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cause a variation in the fuel consumption, it will, nevertheless, be of interest to compare the figures of superheated steam operation with similar ships using saturated steam.

In considering the use of superheated steam, the first question is that of the degree of superheat to be delivered at the engine. The best practice at the present time is for 200 degrees of superheat with reciprocating engines, 100 degrees to 150 degrees with geared turbines, and 250 degrees in turbo-electric-driven ships. There must also be assurance that the specified amount of superheat will be delivered under the varying operating conditions. One of the early difficulties encountered was to prevent the superheat disappearing under abnormal conditions, which, when it happened, permitted water to pass through the superheater and reach the engines. The designs which were faulty in this particular have long since been abandoned in the countries which lead in the use of superheated steam in marine practice.

The selection of proper materials for such details as come in contact with superheated steam is another important question. Steam pipes are best made of steel. Their flanges and fittings may be of semi-steel or cast steel. Valves should have bodies of cast steel or high-grade bronze of suitable composition. Valve springs and seats should be of alloy steel, or its equivalent. In turbines the blades and nozzles are commonly of alloy steel or special material determined by the turbine manufacturers and known by them to be suitable for operating conditions. Turbine casings are satisfactory when made of cast iron or cast steel, as determined by the manufacturer.

In reciprocating engines the cylinders and valve casings are satisfactory when made of a good grade of cast iron, but material which is not satisfactory with saturated steam will not be advisable with superheated steam. Piston valve rings and piston rings do not need to be different in material from what has been used, but in construction may require improvement, particularly if the design in question has been unsatisfactory with saturated steam. Rod packings must be metallic.

With reciprocating engines internal lubrication of the high-pressure valve and cylinder must be provided. Oil suitable for the conditions must be used. It is sometimes claimed that no lubrication is necessary with superheated steam, but experience on hundreds of ships has proven the fallacy of this contention. It may safely be said that, if a reciprocating engine can be satisfactorily operated without lubrication in the valve and cylinders, saturated steam is being used and that the water it contains provides lubrication. It is the absence of this which renders oil lubrication necessary when superheated steam is being delivered to the cylinders.

If steam, either moderately or highly superheated, is used, it is essential that means for determining its temperature be provided. Pyrometers or thermometers should be installed. Pyrometers should have the indicator located on the gage board in the engine room, thus permitting the temperature of the steam from each boiler being read at a glance. There is no better way of determining the firing conditions than by a pyrometer. It makes possible the correction of poor firing conditions in time to forestall a drop in boiler pressure.

Oil filters, of either the pressure or gravity types, as fitted in practically all recently built vessels, are suitable for removing oil and grease from boiler feed water. In superheated steam installations the added quantity of oil required is not sufficient to require increase in the size or number of oil separators. The cleaning of filters and oil separators must not be neglected.

The development of satisfactory superheating equipment has been a long and difficult problem. The rapid increase in the past five or six years in the number of vessels fitted with superheaters is an unmistakable answer as to whether success has been attained, both in respect to the design of the equipment and to the overcoming of operating difficulties. It is believed that a great deal of the reluctance to adopt superheated steam is due to the failures experienced during the days of development and to the fact that many of the marine engineers in this country have had in the past, and in other countries, experience with types of superheater which did not give good service and were abandoned. Modern designs of superheaters in general use are built with these early difficulties as a warning. The materials of construction now available have ensured durability and long life; selection of proper location for superheaters has ensured continuous delivery to the degree of superheat desired; study of details has ensured accessibility and ease in making repairs. In general, it is believed that the present designs of superheater should overcome all but the deepest-seated prejudice against the use of superheated steam.

A Balsa Ice Chest for Deck Installation

EARLY last summer a Swedish steamship company, the Grangesborg Oxelosund, requested the American Balsa Company, Inc., New York, to construct an ice chest for the storing of perishable food products on its ore steamer *Narvik*. Previous to the building of the ice chest the steamer had not been fitted with any arrangement for refrigeration; and as all the space was being otherwise utilized, the bridge deck was decided on as the only possible location. The ice chest, therefore, had to be constructed as a complete unit and swung aboard the ship upon its arrival. Time was an important factor and quick action was necessary.

Fig. 2 shows the details of the ice chest as actually built. A framework was constructed of yellow pine sills

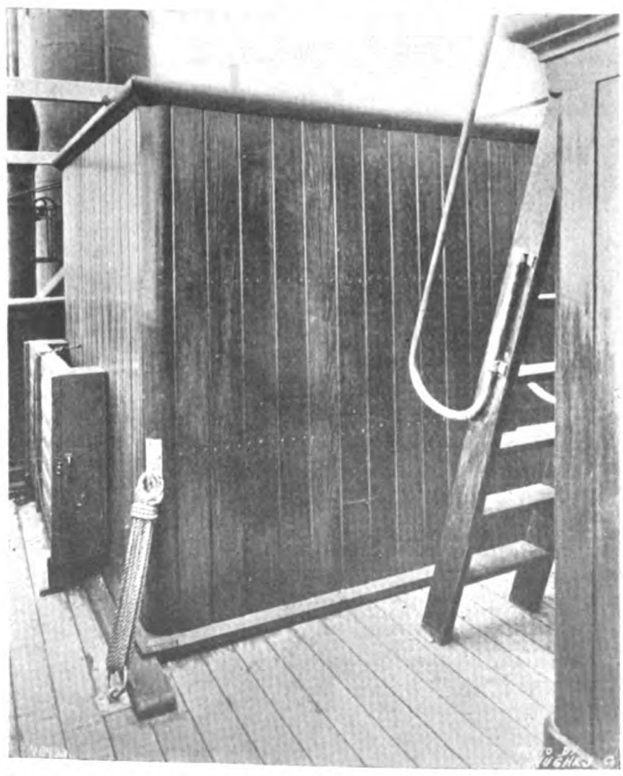

Fig. 1.—Balsa Ice Chest Installed on Bridge Deck of Steamer *Narvik*

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and corner posts, tied together with 1½-inch by 3-inch yellow pine studs, toe-nailed to the sills. Balsa insulation was then put into place and after covering the inside and the outside surfaces with a layer of paper the outside of the ice chest was finished with a layer of 1⅛-inch tongued and grooved yellow pine sheathing. The inside of the chest was similarly lined with a layer of ⅞-inch spruce.

The insulation itself was applied in two layers, the outer of these being three inches thick and placed between the framing and studs. The inside layer was made one inch thick and was installed as a continuous and unbroken lining. It will be observed that by this method of construction the sills, corner posts and studs were completely insulated at all points with Balsa.

An ice bunker was built into one end of the chest, consisting of a grating of 2-inch by 3-inch oak strips placed across the chest on two stringers 16 inches above the flooring. Oak battens 1½ by 1½ inches separated the ice from the side walls of the chest. The ice compartment was divided from the remainder of the chest by a solid 1¼-inch removable oak partition with openings at top and bottom to permit free circulation of air. The entire floor was covered with galvanized iron, over which was laid a grating of spruce, made up in sections to permit of their being easily taken up.

The storage of food products was provided for by a row of shelves arranged along the side of the ice chest and two rows of meat hooks attached to the ceiling. A single door at the end of the chest gave access to the interior. A lashing ring was attached to each of the four corners of the complete chest for securing the latter in place on the ship.

This ice chest was completed in a little more than three days and was ready for swinging on the ship when the latter arrived in New York. After loading the box with ice and provisions a careful record was kept of its performance during the first trip on the steamer to Gothenburg, Sweden. The test was very severe, especially as it took place during one of the hottest periods of the summer. On June 20, about 3,000 pounds of ice, which had been delivered to the pier, were loaded into the ice chest. After the steamer arrived in Gothenburg not all of this ice had melted and the test was accordingly continued until July 14, while the ship was lying in the harbor.

In accordance with the report of the officers on board, about 110 pounds of ice were left on July 14, this being a week after the ship had arrived at Gothenburg, and twenty-five days after the ice had been put into the chest. Neither the ice chest nor the food had been precooled. The door of the ice chest had been opened about three times a day, and on July 14 "the food was in perfect condition exactly as when delivered in New York." The outside temperature during this part of the year varied from 75 degrees to 85 degrees F. in the shade. The ice chest, being located on the bridge deck of the ship, was without any protection and was subjected to the direct rays of the sun and the full force of the elements. The actual temperatures recorded were as follows:

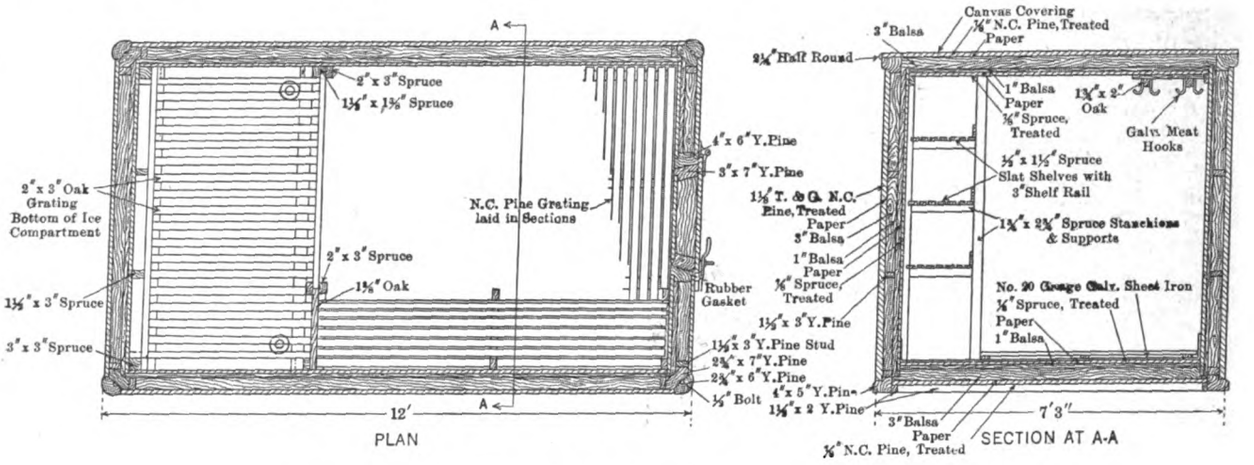

Fig. 2.—Plan and Section of Ice Chest, Showing Details of Construction

	Morning		Evening	
	Degrees F.	Degrees C.	Degrees F.	Degrees C.
June 20.....			59.	15
" 21.....	42.8	6	42.8	6
" 22.....	42.8	6	42.8	6
" 23.....	39.2	4	41.	5
" 24.....	39.2	4	41.	5
" 25.....	41.	5	42.8	6
" 26.....	42.8	6	42.8	6
" 27.....	42.8	6	42.8	6
" 28.....	41.9	5½	42.8	6
" 29.....	41.	5	42.8	6
" 30.....	41.	5	41.	5
July 1.....	40.1	4½	41.	5
" 2.....	39.2	4	41.	5
" 3.....	39.2	4	41.	5
" 4.....	39.2	4	41.	5
" 5.....	39.2	4	41.	5
" 6.....	41.	5	41.	5
" 7.....	41.	5	41.	5

The Balsa with which the ice chest was insulated is the product of a very fast-growing tree, native of Central America. In its natural condition Balsa is subject to rapid decay. It is accordingly "encysted" or treated against rotting by a process owned and perfected by the American Balsa Company, Inc., during which process the Balsa is completely penetrated and the individual cell walls coated with a preservative material. This treatment, however, does not fill the cell walls and the Balsa emerges from the process with a weight of only eight or nine pounds per cubic foot, which is considerably lighter than any other insulator.

After treatment this material is manufactured into large sections up to 36 inches in width and 8 to 10 feet long, corresponding approximately to the distance from floor to ceiling. The individual units of these sections are joined together by special machinery. The result is that such a completed section is to all practical purposes the equivalent of one solid piece, as the joints are both air-tight and mechanically as strong as the material itself.

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The edges of these sections are provided with tongues and grooves. The completed sections are covered with a waterproof coating over which a layer of waterproof paper is applied. When assembling the chest, all that was necessary was to slip these completed sections into place and apply the spruce and pine sheathing, resulting in not only a great saving of time and labor, but producing a well-made and efficiently insulated ice chest.

On the basis of numerous tests conducted by various recognized authorities, Balsa ranks, it is claimed, among the most efficient heat insulators known. It is, however,

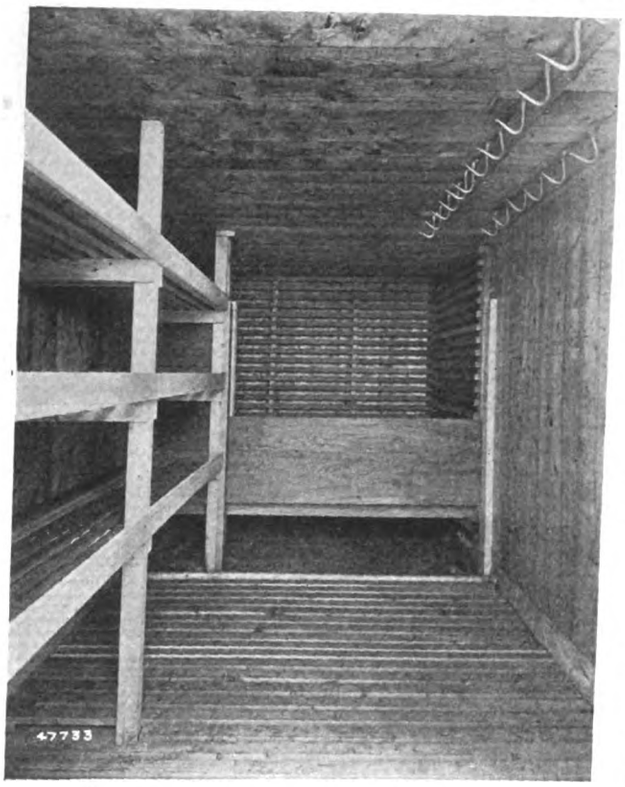

Fig. 3.—Interior of Balsa Ice Chest

the only insulator which has structural strength. In spite of its light weight, its strength per unit of weight is greater than that of spruce. It is, therefore, not only self-sustaining, but can frequently be used to carry some of the stresses of the structure itself. Furthermore, it is not liable to deterioration by shaking down, opening up of joints, etc., and in its waterproof condition will remain indefinitely without absorbing any moisture. In fact, this moisture resistance is so perfect that Balsa is now used in large quantities for the manufacture of fishermen's net floats, life rafts, surf boards and similar buoyancy products which are required to remain in the water continuously throughout a considerable period of their life.

The performance on the steamer *Narvik* was considered so gratifying that the additional steamers of this same company have been equipped with similar installations which have served in an equally satisfactory manner.

Everybody has struck days when everything seems to go wrong. Early in the day something vexes us, we pass it along to someone else and soon our nerves are on edge. The thing to do is to sit down and look at things for a few moments and say, "Steady now, don't get excited. Nothing is wrong, except myself." If we are good natured, we can get the work going smoothly. Just be calm—it will pay you well.

Increased Activity in Vessel Design and Brokerage

AS an evidence of the increasing importance of shipbuilding and ship operation in all its branches, the development of the firm of Cox & Stevens, naval architects and engineers, New York, is of interest. This firm has been in operation for some fifteen years and has divided its attention between commercial vessels and pleasure craft. During the past six years the volume of its business has increased to such an extent that additional space has become necessary, where its designing work could properly be carried out. The main office of the firm is still at 15 William street, New York, where vessel and yacht brokerage is conducted and where the members of the firm transact their business, but a new office has been established in the Terminal building at Borough Hall, Brooklyn, which is within fifteen minutes of New York via the subway, where the designing office and drafting room are now located.

Designing Department

This arrangement has been in force for several months and is found to work well. As a result, the professional work proceeds under admirable conditions and without interruption, and, in addition, owing to the space available in the Brooklyn office, a large additional force of draftsmen can be put on at any time to take up special or rush work. Highly qualified men are in charge of the various branches of the work, which are under separate management, so that the various departments are kept separate, the entire organiation as a whole being under one control.

In the early days of its activities Cox & Stevens was perhaps best known in connection with yacht design and yacht brokerage, which departments have always been operated at high efficiency, the volume of business in these branches equalling, if not exceeding, that of any other similar organization. Many well-known and successful pleasure craft, including seagoing yachts, fast express turbine yachts, house boats, motor boats and sailing vessels, have been built from their designs. Subsequently it developed that there was a larger field in the design and superintendence of construction of commercial vessels, and the firm has given an increasingly large portion of its time to this work, without, however, in any way neglecting the yachting field.

Many types of commercial vessels have been designed by them and built under their supervision. These vessels, of both wood and steel, include sailing vessels, auxiliaries, barges, dredges, towboats, river craft, steamers, motor vessels and tankers. The submarine tender *Fulton*, the first full Diesel-engined motorship in this country, was designed by this firm, as well as some of the earliest geared turbine and motor-engined tankers.

Consulting Engineering Work

Cox & Stevens not only act in the capacity of naval architects and engineers for new construction, conduct an active brokerage business, are consulting engineers for several steamship companies, looking out for their floating equipment and superintending their new work, but act in an advisory capacity for a number of shipbuilding companies, placing at the disposal of these companies their designing staff for special problems. This they can readily do without interfering with their routine work on account of their large staff and excellent quarters.

Among the most important recent undertakings that this firm has executed or is now in process of handling may be mentioned: forty auxiliary schooners, twenty steamers

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Fig. 1.—Conference Room

Fig. 2.—Entrance Showing File and Consulting Rooms

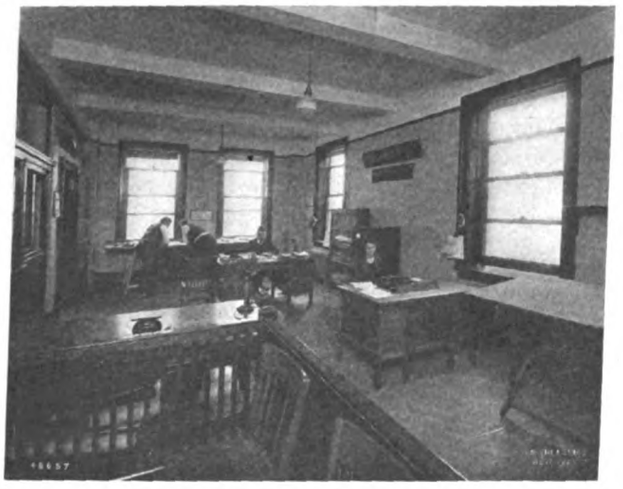

Fig. 3.—Corner of Drafting Room

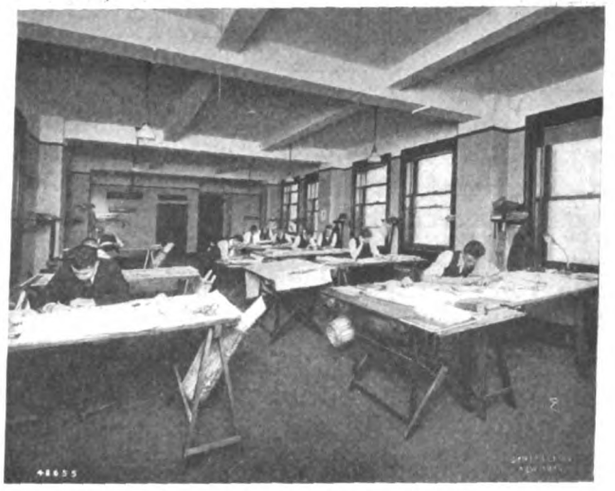

Fig. 4.—Drafting Room

and thirty-eight mine sweepers for the Foundation Company, twenty trawlers for the East Coast Fisheries Company, one hundred and twenty-four steel vessels, including towboats, self-propelled barges and barges without power for the United States Railroad Administration, the superintendence of new construction for the Aluminum Company of America, including two steamers, two ocean-going barges and a number of river craft, the superintendence of two 10,000-ton steamers for the Shawmut Steamship Company, the rearrangement as passenger vessels and the conversion to oil burning from coal of several large steamers for the Shipping Board, and the design and superintendence of construction of the largest Diesel-engined yacht that has yet been built in this country.

Financial Advisers

In addition to their strictly professional work, Cox & Stevens have confidential relations with a number of banking houses interested in shipping investments, and in this capacity find a considerable field for their activities, as such bankers naturally require responsible advice before concluding their negotiations.

The history of this firm shows that there are remarkable possibilities in the field in which they operate, provided a good organization is maintained and work is done upon the basis of giving satisfaction to those for whom the work is being done.

Unfinished Waterway Programme

TEN years ago Congress adopted a general plan for the improvement of the main waterways of the Mississippi valley. The original plan provided that this work should be completed in ten years, but now that the time is up the work is not completed.

The main lines of river transportation embodied in the original plan comprised the routes from Pittsburgh, St. Paul and Kansas City to New Orleans by way of the Ohio, the Mississippi and the Missouri rivers. These main lines are fed by many tributaries which should be improved as soon as the main channels reach such a condition of service as warrants their further expansion. Part of this work has been accomplished and the remainder could be completed in three years at a total cost of less than $50,000,000 (£10,250,000).

New Appropriation Needed

In view of what has already been accomplished and the possibilities which may be developed, it would be a short-sighted policy not to complete the ambitious programme of inland waterway improvement which was begun a decade ago. A new appropriation, small as such appropriations go, is needed for the next year's work in bringing this project to completion, and immediate steps should be taken to get the necessary legislation through Congress to accomplish this purpose.

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Why Beat About the Bush?

JUST when Congress should be shaping up a definite, clearly defined plan for dealing with the merchant marine, the Senate committee on commerce is being swamped with opinions and suggestions from interests both directly and remotely concerned with the question. Consequently, instead of unity of thought or purposeful direction in its deliberations the committee is forced to deal with a mass of ideas varying so widely that in some cases it is almost impossible to reconcile the differences. Under these conditions any immediate satisfactory settlement of the problem seems to be out of the question.

Long ago Congress made it plain that when the shipping interests decide on just what they want and make their desires known with some degree of unanimity, proper action will be taken. Never before was there such a splendid opportunity to place the shipping interests of the country on a sure footing for future development along lines in accordance with sound principles and equitable relations with the business and transportation interests of the country. But Congress, with all its faults, cannot be blamed for delays and inaction, if the people directly interested cannot come to some sort of agreement as to what measures will be best for their business and for the country at large.

Foreseeing the difficulties, if Congress were left to coordinate the wide differences of opinions which were certain to be encountered in a case of this kind, the National Merchant Marine Association was formed months ago by the interests most directly concerned in the future of the merchant marine and therefore best qualified to determine a feasible policy for its development. In due time this association formulated a policy proposing a definite method of disposing of the government-owned vessels and establishing under private control passenger and freight service to such countries as appear to offer the best opportunities for the expansion of our foreign commerce. The recommendations offered by this association have had the indorsement of practically all interests definitely concerned in the matter, and it is safe to say that they represent the consensus of opinion of the country at large.

Just what Congress asked for has been done. But, in spite of this, the question seems likely to become involved in a long, vexatious and costly delay which will upset business and play into the hands of our competitors in the overseas carrying trade. Why beat about the bush when so much is at stake?

Progress of American Shipbuilding

SUPPLEMENTING the figures published in our last issue showing the delivery of over six million deadweight tons of merchant ships to the Shipping Board by American shipbuilders in 1919, we are now able to give complete returns from the Bureau of Navigation, Department of Commerce, showing the number and tonnage of merchant vessels built in private American shipyards last year and officially numbered for American shipowners. According to these figures the total output of American shipyards for the calendar year 1919 consisted of 2,338 merchant vessels of 4,213,891 gross tons for American owners, and 25 vessels of 44,250 gross tons for foreign owners, making a total output of 2,363 vessels of 4,258,141 gross tons for the twelve months. As compared with the output in 1918, this shows an increase of 481 vessels and 1,536,860 gross tons. Of the 1919 output, 916 vessels of 3,569,824 gross tons were built of steel, an increase of 434 vessels and 1,699,465 gross tons over 1918.

Just what this year's record output of shipbuilding means to the standing of the United States as a maritime nation is perhaps better shown by a glance at the figures for the new American merchant marine in operation at the beginning of the current year. On January 1, 1920, the American merchant fleet consisted of 28,731 vessels of 15,441,786 gross tons. This is double the total merchant shipping which the United States possessed before the war, and is, as a matter of fact, nearly as large as the merchant fleet of Great Britain. As compared with the British merchant marine, however, which is almost wholly engaged in foreign commerce, the American merchant fleet is divided between foreign and domestic service in the proportion of about three to two—that is, our overseas fleet totals approximately 10,000,000 tons, or about three-fifths of the amount of British tonnage engaged in foreign commerce.

Having thus doubled our merchant fleet in the past two years and come into the possession of over one-quarter of the steel steam tonnage of the world, interest naturally centers in the prospects for future production in American shipyards. As a matter of fact, about a million gross tons of steel steamers, independent of those being built for the Shipping Board, are now under construction in the shipyards of the United States, and with one exception all of these vessels are for American owners. The fact that the tonnage now actually building to the order of private enterprise is practically equal to the full decrease

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in the work of a similar type for the Shipping Board, brought about by the completion of government contracts, gives good promise of the future of American shipbuilding on its present basis.

If further encouragement as to the future of the American shipbuilding is needed, it can be found in a statement just issued by the Atlantic Coast Shipbuilders' Association, which shows that the volume of merchant tonnage ordered by private interests since the signing of the armistice practically equals the volume of the entire seagoing shipping of the country at the outbreak of the war. Furthermore, the merchant tonnage now under construction for private ownership is seven times as great as the ship construction of all types under way in this country at the beginning of hostilities. Summaries prepared from the official records of the American Bureau of Shipping and Lloyd's show a gain in the output of merchant tonnage in American yards for the past month of nearly 175,000 gross tons. Since last September the gain has amounted to more than 625,000 tons. How steady the increase has been is shown by the total under construction for the past four months. In October it amounted to 347,343 gross tons; in November, 550,714 gross tons; in December, 805,147 gross tons, and in January, 977,488 gross tons.

A feature of the returns is the marked demand for tanker tonnage. In October last, according to the statement of the Atlantic Coast Shipbuilders' Association, the excess of freighters over tankers in course of construction for private account in American yards was 59,000 gross tons, but today tanker tonnage leads. While the freighter tonnage being built for the Shipping Board is at present considerably in excess of that on the ways for private account, the reverse is the case in relation to tankers, the total under construction for the government being about 274,000 gross tons, as compared with 476,000 tons building to private order. Standard Oil companies lead in the amount of this type of tonnage being built, but more than 325,000 tons of the 476,000 tons total is for other concerns.

In the amount of tonnage being constructed, the Federal Shipbuilding Company, Kearny, N. J., leads the way with 35 vessels of 208,276 gross tons, composed of 26 freighters aggregating 156,276 tons, 5 tankers totalling 50,000 tons, and 4 barges of 2,000 tons total. The Bethlehem Shipbuilding Corporation follows with 24 vessels of 184,888 tons, of which 23 are tankers aggregating 177,738 tons and one an ore carrier of 7,150 tons. The Sun Shipbuilding Company has under way 13 tankers of 91,017 tons and a freighter of 7,700 tons. The largest amount of freighter tonnage being built for one concern consists of 20 vessels aggregating 120,000 tons for the United Steel Corporation.

Another gratifying sign is the continued increase in the number of yards engaged on private contracts. In October these totalled 27; in November, 31, and in December, 38. For January the figure has risen to 43. Confidence of American shipbuilders that there would be a market for American steel tonnage well beyond present demands is most strikingly shown in the way in which builders have been taking over for their own account contracts cancelled by the government. About 175,000 gross tons of vessels are now being built in this way, seven yards having taken up contracts for 35 freighters totalling 142,158 tons, and three yards continuing work on 5 tankers aggregating 32,000 tons. Of the 188 vessels of various types under construction in American yards today, only one is building for foreign account, so that American shipbuilding is practically a one hundred percent American supported industry.

Superheated Steam

IN comparing the efficiencies of the various types of engines and the efficiencies of propulsion of the different combinations as applied to the actual work of propulsion, Rear Admiral Dyson, in a paper recently published in the *Journal of the Society of Naval Engineers*, states that where superheat is applied, even in small amounts, the advantage derived is of such great amount as to be worthy of the most serious consideration. In one case cited the gain in water consumption at 30 percent full power, with 41 degrees superheat, is 6.7 percent; at 50 percent of full power, with 46.3 degrees superheat, the gain has risen to 7 percent; at 100 percent of full power, with 58.6 degrees superheat, the gain is 8 percent. In general, it is stated that an average rough figure for the gain due to superheating may be taken as one percent for every ten degrees of superheat.

While the advantages of superheated steam are fully recognized by the navy, in merchant practice in the United States there seems to be an attitude of stubborn resistance towards its use, except in the case of low-degree superheaters, which in effect are steam dryers. Abroad, however, rapid strides are being made in the adoption of superheated steam in merchant vessels, and this chiefly in the direction of superheating to 150 or 200 degrees. Convincing evidence of this is given in data published elsewhere in this issue. Here it is shown that at the higher rates of engine power the saving per degree of superheat increases, although the degree of superheat is not increased to a marked extent. Due to the tendency towards higher-powered vessels in present merchant practice, this saving is one of the excellent reasons why highly superheated steam is in such common use abroad and explains its rapid increase in popularity, as evidenced by more than 2,000 vessels in operation or building which are so equipped.

The economies of fuel resulting from the use of superheated steam are of such importance in these days of keen competition for the supremacy in overseas trade that this valuable accessory to the marine steam power plant cannot be ignored. Modern designs of superheaters present quite a different problem from the earlier experiments which aroused prejudice and antagonism toward this development. With the present successful designs of superheaters there seems little excuse for the deep-seated prejudice against superheated steam.

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The Metric Fallacy*

UNDER the above title, Frederick A. Halsey, Commissioner of the American Institute of Weights and Measures, has published a book of over 200 pages containing the results of an investigation of the claims made for the metric system, and especially of the claim that its adoption is necessary in the interest of export trade. In the United States little attention would probably be given to the idea of adopting the metric system, if it were not for the fact that a certain amount of propaganda has been carried on recently throughout both the United States and Great Britain appealing to all classes of people for the support of a movement to secure legislation by the United States Congress and the British Parliament, making the use of metric weights and measures compulsory and prohibiting the use of the English weights and measures now established. Since this movement has been started there has been a too ready acceptance of its arguments by a certain class of newspapers and publications, and by the unthinking public, with the result that steps have been taken to introduce in Congress measures to compel the adoption of the metric system.

The argument for the adoption of the metric system, it is pointed out by Mr. Halsey, is based upon the tacit assumption that it is a simple matter for a country to change its weights and measures; once one has accepted that assumption it is but a short step to the conclusion that those countries which have made the experiment have succeeded: and then another short step to the conclusion that the experiment can be carried out successfully in this country. As it is on this argument, or theory, that the entire metric case is based, Mr. Halsey shows what actually has been accomplished in twenty attempts to bring about this change in other countries, most of which date from about the middle of the last century. With but one exception, the result has been grotesque failure, while in no case has the attempt to retire old units been successful.

Taking up the use of the metric system in export trade, the statistics show that 82 percent of American exporters to metric countries do not use the metric system at all in production, while 14 percent use it partially and only .3 of 1 percent really use it exclusively. The conclusion drawn from the investigation is that the commerce of the world is conducted by the English system and that the current phrase, "the international metric system," is nothing but a pretext and a sham.

In the commercial use of the system the results are equally striking. According to the statistics compiled in this book, it is shown that 1.6 percent of American exporters use the metric system in response to a commercial need, but that not one uses the system exclusively. While 38 percent of the exporters make some use of it in shipments, because they are compelled to do so by the laws of foreign countries, these uses, as a matter of fact, show how trifling is the influence of such laws when confronted by the customs of commerce.

In Great Britain, where similar attempts have been made to gain a foothold for the metric system, the subject has been given very careful consideration by special Parliamentary committees, and the result in each case has been a failure to recommend the compulsory adoption of the metric system. The British committee, representing the shipbuilding and shipping industries, stated that "so far as shipbuilding and marine engineering are concerned, we see no reason for the change. That part of the metric system involving the decimal subdivision of time and the right angle is most objectionable, and, if adopted, would most seriously prejudice the interests of navigation."

Before attempting to adopt a new system of weights and measures or change the present system, the outstanding features of the present weights and measures of the world should be considered. In this book they are stated as follows:

1. The universal use of the English system in navigation and sea measurements.
2. The overwhelming preponderance of the English system in manufacture.
3. The overwhelming preponderance of the English system in international trade and commerce, due to the fact that the United States and Great Britain are the chief manufacturing and trading nations.
4. The fact that the forces of trade and commerce have carried the English system to every quarter of the globe.
5. The fact that all the nations investigated use the English system and are perfectly familiar with it.
6. The fact that the people everywhere do not like the metric system and refuse to use it except to the extent to which they are compelled by law.
7. The fact that the attempt to adopt the metric system has been followed by failure after failure.
8. The great similarity of the English and Spanish system, which are substantially identical in structure, their differences being chiefly in the value of units which, in most cases, are practically negligible.
9. The fact that in five countries of Latin America this slight difference in values of units of weight (⅔ of 1 percent) has led to the general adoption of the English values.
10. The fact that German influence, which, in the past, has been largely responsible for the propaganda in favor of the metric system, will in future be negligible.

All these conditions, it is pointed out, open up a great opportunity for the unification of the weights and measures of North and South America and the British Empire on the basis of the system which is common to all.

Here, says the author, is a simple, sensible, practicable plan for the promotion of the commercial relations of the two Americas and of the British Empire. Nothing, in his opinion, would so promote international trade and assure the dominance of the English-speaking peoples over Germany in industry and commerce. In other words, to promote the English system is to work for the interests of the English-speaking peoples; to promote the metric system is to work for the interests of Germany.

Certainly, without some better arguments than those so far given, there seems little excuse for any attempt to promote the adoption of the metric system in the United States. If for certain industrial or commercial purposes it is found desirable to use the metric system, its adoption for this particular purpose should be optional with the manufacturer or producer concerned. Any attempt to make its adoption compulsory would result only in failure, confusion and vast unnecessary expenditures, the benefits from which would be practically negligible.

A steering engine is, or should be, a very simple machine, yet it is surprising how many engineers cannot explain how it works. It pays to know all about the engine that steers your ship. Get a catalogue from its makers and read up on the subject.

Feeding a man and feeding a boiler should not be done in the same way. A man takes his food every so often, while the feeding of a boiler should be a "continuous performance" if you want the best results.

When you are on watch, watch.

* Published by the American Institute of Weights and Measures, 115 Broadway, New York. Size, 6 by 9 inches. Pages, 229. Illustrations, 2. Price, $3, postpaid

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LETTER TO THE EDITOR

Lake System of Dry Docks

Editor MARINE ENGINEERING:

The writer notes in the December issue, among "Letters to the Editor," a criticism of the above-named system, written by F. W. Erickson, vice-president and general manager of the Marine Engineering & Dry Dock Company of Rhode Island. Carefully considering the points brought forth in the criticism, the writer finds that Mr. Erickson must have misunderstood the way of operating the system in question, else a reference would not have been made to perpetual motion or to lower level chambers.

The system of dry docks evolved by the writer relates simply to dry docks all located at sea level and interconnected by conduits. These conduits serve to transfer water from one dock to another as required. With this arrangement in view, it is self-evident that the pumping step heretofore necessary can be eliminated in a large degree. Also can the time required to empty a dock be reduced to a minimum.

May the writer, for the sake of explanation, take two dry docks, No. 1 and No. 2, of same size, located both at the sea level and interconnected by conduits? In each of these docks is a ship repaired and ready to go out, but so far both docks are empty of water. The operation of this system is now as follows:

Step No. 1.—Dock No. 1 is filled with water and the ship goes out, after which the sea gate is closed.

Step No. 2.—The valves in the conduits are opened. It is now evident that the water from No. 1 dock will flow into dock No. 2 until a common level has been reached in both docks.

Step No. 3.—The valves in the conduits are now closed and the remaining water in dock No. 1 is pumped out. Dock No. 2 is meantime filled from outside water to sea level.

Step No. 4.—The ship in dock No. 2 goes out and then the sea gate is closed. Meantime the blocks in dock No. 1 are set for the next ship.

Step No. 5.—Now the valves in the ducts are opened and half of the water in dock No. 2 will consequently flow into dock No. 1.

Step No. 6.—The valves are then closed again and the remaining water in dock No. 2 is pumped out. Meantime dock No. 1 is filled from outside water to sea level.

Step No. 7.—A new ship for repair is now floated into dock No. 1, after which the sea gate is closed. Meantime the blocks in dock No. 2 are set for a new ship.

Step No. 8.—When this is done, the valves in the ducts are opened and water from dock No. 1 flows into dock No. 2 until a common level is reached.

Step No. 9.—The valves are hereafter closed and the remaining water in dock No. 1 is pumped out. The ship in this dock is now docked. Meantime dock No. 2 is filled with outside water to sea level.

Step No. 10.—Sea gate for dock No. 2 is opened. A new ship is floated into that dock, after which the sea gate is closed. The operation is finished by pumping all the water out from dock No. 2. Both new ships for repair are now docked.

In common practice at present it would be necessary when docking these two ships to pump out all water twice from each dock, thus involving 100 percent of pumping. Through the system in question the pumping step is reduced to 62 percent. If three docks were used in the operation the pumping step would be reduced by at least one-half, or 50 percent. Again, in case one dock should be much smaller than another dock in the system, it could happen that all water from the smaller dock twice could be emptied into the larger dock. No pumping from the smaller dock would in that case be necessary when docking a new ship for repair in that dock, thus accomplishing a 100 percent saving in pumping. The larger dock would, of course, be pumped out twice before a new ship for repair could be docked, in case no other dock in the system is at hand for combined operation.

In some instances, again, it may occur that the water discharged from a smaller dock will be insufficient to fill a larger dock to a depth sufficiently great to interfere with the repair work which is proceeding upon a vessel in that dock. Thus, for example, a large vessel, which has had its shell plates repaired and the work being done is well up on the body of the vessel, the water admitted from a small dock would not rise sufficiently to interfere with the work being done.

It will, of course, be understood that the best results from the use of the system in question are attained by careful planning of the work to be done on any vessel and the time of receiving and discharging the vessels. This can very well be done. The system in question points only toward a reorganization of docking of vessels. The way of docking at present is more or less an inefficient one.

Concerning loss due to leakage through the interconnecting ducts, the writer may here refer to the Panama Canal, where the parallel locks are similarly interconnected as the docks in this system. The valve arrangement in the Panama Canal is satisfactory, and satisfaction can consequently be reached also in this case.

Regarding the expense of installing ducts between already existing dry docks, that expense will soon be outbalanced by the increased efficiency of the dry dock plant. When installing the conduits, only one dry dock at a time would have to be out of operation, or excavation could also very well be done meantime when ship repair work is going on in the dry docks. Concerning projected dry docks, the additional expense of installing interconnecting ducts will be very small in proportion to the cost of building the dry docks proper.

The cost of operating this system will be only a part of the cost of the present operation of dry docks. The pumping step is considerably reduced, and the transfer of water from a fitted dock to an empty one by gravity becomes merely a matter of opening and closing the proper conduits. Electricity can be used for this purpose.

The disadvantage caused by interdependence between the dry docks in a plant is only apparent. It is evident that in a large docking system, consisting of, say, three or more dry docks, a considerable number of combinations are possible, where the docks are interconnected, and it is possible so to schedule the operations that one dock may always be flooded and in receiving condition, while others are simultaneously ready to discharge a vessel or vessels. At the same time it is self-evident that in a dry dock plant, where interconnecting ducts are installed, these ducts do not need to be used in cases when the use of them would be inconvenient. Pumps are always at hand to do all the work in such instances. The system will be found most convenient in cases when a dry dock plant is working on short orders, i. e., when dockings of ships are done for inspection, changing of propellers, painting of bottoms, etc.

There is no reason why the dry docks in a plant should be separated when they can be interconnected.

Philadelphia, Pa. JOHN LAKE.

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Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Notes on Joining a New Steamer

The chief and first assistant engineers are, as a rule, appointed after a vessel is launched and is lying alongside the fitting-out wharf for machinery installation. As the general plans, materials, etc., have, of course, been approved by the owners, United States inspectors and Lloyds or other underwriting society, the engineers are more concerned in the actual workmanship with which the vessel is constructed.

The double bottoms and deep tanks, which have been tested when the ship was on the slip, are now ready for final cleaning and to be covered with preservative composition. They should be carefully examined and the height taken at sounding pipes. The pipes are improved if they are perforated inside the tanks to allow a free circulation of oil or ballast in the pipe.

In a recent case a steamer ran short of fuel and was towed to port. The deep tanks were constructed on top of the double bottoms, the bilges being included in the tanks. As it was found that the sounding pipes extended to the bottom of the bilges and showed a false depth of nearly four feet in each tank, the engineer's license was suspended.

As all suction pipes are carried through the double bottom, it is important that they be in perfect condition before they are closed up and filled with fuel or ballast. They should be well secured with hangers and kept well clear of the framing to prevent chafing.

Pipes extending from bulkhead to bulkhead in the tank should have a 90-degree offset and not be in a straight line, to prevent any strain when the ship is working in a sea-way.

Examine all pipe flanges and bulkhead fittings, for it is not unusual to find them broken. Moreover, the bolts and gaskets are sometimes missing.

Trace pipes to their manifold valves and make sure that they are correctly tagged. Do not depend on the blue prints.

Deep tanks and peaks are fitted with a valve on the bulkhead inside the tank. To prevent flooding of other compartments in case of accident to the suction line or manifold, an extension rod is fitted from the valve stem through the tank top to the deck. Pay close attention to this rod; it should fit securely on the valve stem and have a rigid guide bracket every eight feet. A thick washer fitted with a tap screw, secured on the rod under the tank top fitting, will prevent the rod unshipping when operating the valve.

The double bottoms and deep tanks are very important to the chief's comfort, if he knows that they are in perfect order. Fuel in a tank with defective suction might as well be in the oiling station ashore—in fact, better, for the tank would then be empty and so nearer to being ready for repairs.

After the tanks are covered with composition, make a final examination, for sacks, paint brushes and old buckets are liable to be left behind. Get the tank doors on at once and fill in around the edge of the plate with cement. In the writer's experience on a new steamer, taking oil into a midship deep tank "over the top"—that is, through the manhole—the steward was unpacking his glassware and three sacks of excelsior found its way into the tank, and we, two months afterwards at sea, pulled it out of the manifold valve.

Boilers are lowered into place with all fittings attached. They are built under close supervision and the engineers will probably not see them until they are on the wharf. Feed, surface and bottom blow, steam and escape pipes are connected up. These pipes should not be sprung into place, but come fair flange to flange and hole to hole. Copper pipes are fitted with hangers lined with sheet lead, giving a snug fit for the pipe, which should not pinch.

The delivery pipe from the injector should come into the feed pipe with an easy sweep and not into a tee. It is good practice to have as direct lines as possible on the injector.

After the boilers are tested, brush down and clean out thoroughly; fill with fresh water, and, to a 20-ton boiler, add 100 pounds soda ash. Light a wood fire in one furnace and boil out. A wood fire prevents forcing the boiler. If it is possible to get clean salt water, this should be used to boil out the boiler, but it is difficult to get at the average shipyard.

During the time that the boilers are warming up, scrape the shell and cover with two coats of fish oil to prevent rusting.

The lagging blocks should be packed closely and finished with asbestos cement. Pay particular attention to the lagging around the bottoms of the boilers. This is a slow and difficult job and is sometimes scamped. It is interesting to watch the difficulty in warming up a boiler before lagging, and the ease with which it is accomplished after it is properly lagged.

After the lagging has dried out, galvanized sheeting is fitted over it. The sheeting around the bottoms of the boilers is worth attention. In some jobs the lagging is made portable over the combustion stay ends, as this allows a frequent examination of this important part of the boiler.

After the boilers are well boiled out (the writer has found three days sufficient) they should be pumped out, thoroughly scraped and wire-brushed, and kept dry until they are required for the dock trials. Replace the manhole covers to keep out dirt.

Examine the studs securing the breeching to the shell. Sometimes they are broken, and it is nobody's business to report it. The breeching should fit closely around the boiler shell and packed with 1/8-inch asbestos sheet to prevent air leaks.

The forced draft air ducts are a favorite place to stow template sheets and other rubbish. The writer has traced

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several complaints of bad draft to template sheets blanking the air heating tubes.

The lagging on steam pipes should be portable over the flanges to permit examination of the pipe at the back of the flange, as any defect is almost sure to be found at this place.

Whistle pipes are connected directly to the boiler and a straight lead will keep them drained. This also prevents freezing in cold weather. Leading the pipe to the whistle inside the stack casing is good practice.

In installing the engines, the tail and main shafting being lined up, the rivet points on the thrust block stool are flushed and the thrust block and shaft lowered in place. The after coupling flange should be trued to the forward flange by means of steel wedges under the thrust block. Chocks are then fitted, holding down bolt holes are drilled and bolts hammered down solid. Check up the couplings for fairness after all is finished.

The engine bed plate is fitted in the same way, taking care that the rivet points are flushed. Turbine engines are fitted in a similar way, the reduction gear being first lined up and secured, then the turbine lined to the reduction gear. Alternate holding-down bolts in thrust and engine beds are machined and made a driving fit for the holes, which are reamed true to size.

On some jobs end chocks are fitted, to prevent lateral motion of the bed plates. The fitting of chocks requires skill to make a good job, but generally any man is good enough, so close attention should be paid to it. Each chock must have a good face bearing and a driving fit. Try each with a thin searcher and tap with a testing hammer.

Everything depends on the engine and shafting being in line and having a good solid foundation.

As the engines are assembled all working parts should be covered with clean canvas or burlap and securely lashed. When coupling up piston rods and other tapered fits, use mercurial ointment instead of oil. They will come adrift at any time without heating.

In the case of the auxiliary machinery the stool plate of pumps is improved by flanged edges to form a pan. Fitted with a drain pipe to the bilge, it keeps the engine room platform clean. There should be enough space around the pump for overhauling and for withdrawing the rods.

Pipe connections that are fitted fair, instead of being sprung into place, save hours of work and trouble at sea. Gaskets of well-laid pipe lines do not give any trouble.

Pipe hanging is another job that is not in demand among shipyard men. It is neglected in most yards, and nothing is more annoying than loose and vibrating pipes. Hangers should be spaced about nine feet apart.

Pumps, as delivered from the makers, have rubber gaskets and packing. Any pump that is to handle oil requires fiber gaskets and a packing designed for oil.

The electric plants now installed on new steamers give little trouble. Any conduit pipe exposed to the weather or other dampness should be painted at sleeves and outlets with black japan or enamel. Make sure that the deck fittings are really watertight and that the glass globe is cinched tight against the gasket.

If the steering engine is operated by a telemotor it is important that telemotor and valve lever are in line when the rudder is hard over, as well as when it is amidships. If it is fair when amidships and high and low when the telemotor is hard over either way, this is the cause of many stiff wheels, and also of the wheel not running back to the center.

The foundation bolts of the deck machinery should be accessible. They are sure to slack back in time, when the nuts are sure to be tight.

The dock trial is simply a preliminary running of the machinery when the ship is alongside the wharf, so that any defect may be remedied. Various speeds are run and no data are taken.

On the trial trip, have the settling tanks sounded when the bell rings that the ship is at full speed on the measured mile and again when she has finished. Take the register at the end of each mile, also pressures, temperatures, revolutions and strokes of auxiliaries. A draftsman is generally in charge of the indicating, and he will supply you with a set of cards taken on each run.

The assistant engineers can be usefully employed in observing the actual running of the machinery. Too often they depend on the shipyard crew to detect hot bearings and other defects. This is a good chance to judge an assistant's character and to act accordingly.

After the measured mile the ship proceeds on an endurance run, generally four hours. The fuel should be measured at the start and data taken every half hour, measuring the fuel at the finish of the run.

On the run back to harbor the speed of the ship on the measured mile and on the endurance run can be obtained from the captain, who will probably be interested in how the machinery ran. The data tabulated and averaged give the performance of the ship in ballast without cargo. An oil tanker generally runs her trial ballasted to the load line.

The deep-sea trial is an endurance trial after the ship is loaded and ready for sea. Twenty-four hours is a fair run. The fuel is measured and data taken as in the light trial.

The engineer's industry during the time the ship is in the shipyard will be rewarded by the absence of those small defects that are otherwise sure to crop up.

OIL FUEL.

Trouble With a Generator Set

When MARINE ENGINEERING comes aboard, the first thing I do is to look at the front page and read the advertisements. Then I turn to the letters from engineers, as I get a great many good points from them.

We have two electric sets on board. They each develop 15 kilowatts and run at 550 revolutions per minute. The engines are enclosed and are fitted with a forced system of oiling, the only one fit for such high speeds. The engines have been in charge of the chief for over three years and have never given any trouble. In that time the bearings have been taken up but once.

A few weeks ago oil began to run out of the case where the crank shafts pass through the casing, and this made things very messy. It seemed strange to me that both plants should start leaking at the same time. But if one did, why not both?

The chief thought the leak was caused by the packing wearing in the casting which was bolted to the engine bed. This casting was split so the top half could be taken off in order to take out the shaft. Where the crank shaft passed through this casting a recess had been turned and square packing put in it. The casting, bolted to the bed, formed a pocket for the oil to drip into from the crank shaft bearing.

The chief ordered me to take a man and repack the casting. I got an oiler named Girdwood. He had been chief on a tramp steamer, but got to drinking and at last had to go to oiling. He was Scotch, and when not drunk was a very good man. When I got the top half of the casting off I gave it to Girdwood and told him to go and get some new packing while I dropped off the lower half.

He looked at the packing and at the shaft, and in his

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Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Notes on Joining a New Steamer

The chief and first assistant engineers are, as a rule, appointed after a vessel is launched and is lying alongside the fitting-out wharf for machinery installation. As the general plans, materials, etc., have, of course, been approved by the owners, United States inspectors and Lloyds or other underwriting society, the engineers are more concerned in the actual workmanship with which the vessel is constructed.

The double bottoms and deep tanks, which have been tested when the ship was on the slip, are now ready for final cleaning and to be covered with preservative composition. They should be carefully examined and the height taken at sounding pipes. The pipes are improved if they are perforated inside the tanks to allow a free circulation of oil or ballast in the pipe.

In a recent case a steamer ran short of fuel and was towed to port. The deep tanks were constructed on top of the double bottoms, the bilges being included in the tanks. As it was found that the sounding pipes extended to the bottom of the bilges and showed a false depth of nearly four feet in each tank, the engineer's license was suspended.

As all suction pipes are carried through the double bottom, it is important that they be in perfect condition before they are closed up and filled with fuel or ballast. They should be well secured with hangers and kept well clear of the framing to prevent chafing.

Pipes extending from bulkhead to bulkhead in the tank should have a 90-degree offset and not be in a straight line, to prevent any strain when the ship is working in a sea-way.

Examine all pipe flanges and bulkhead fittings, for it is not unusual to find them broken. Moreover, the bolts and gaskets are sometimes missing.

Trace pipes to their manifold valves and make sure that they are correctly tagged. Do not depend on the blue prints.

Deep tanks and peaks are fitted with a valve on the bulkhead inside the tank. To prevent flooding of other compartments in case of accident to the suction line or manifold, an extension rod is fitted from the valve stem through the tank top to the deck. Pay close attention to this rod; it should fit securely on the valve stem and have a rigid guide bracket every eight feet. A thick washer fitted with a tap screw, secured on the rod under the tank top fitting, will prevent the rod unshipping when operating the valve.

The double bottoms and deep tanks are very important to the chief's comfort, if he knows that they are in perfect order. Fuel in a tank with defective suction might as well be in the oiling station ashore—in fact, better, for the tank would then be empty and so nearer to being ready for repairs.

After the tanks are covered with composition, make a final examination, for sacks, paint brushes and old buckets are liable to be left behind. Get the tank doors on at once and fill in around the edge of the plate with cement. In the writer's experience on a new steamer, taking oil into a midship deep tank "over the top"—that is, through the manhole—the steward was unpacking his glassware and three sacks of excelsior found its way into the tank, and we, two months afterwards at sea, pulled it out of the manifold valve.

Boilers are lowered into place with all fittings attached. They are built under close supervision and the engineers will probably not see them until they are on the wharf. Feed, surface and bottom blow, steam and escape pipes are connected up. These pipes should not be sprung into place, but come fair flange to flange and hole to hole. Copper pipes are fitted with hangers lined with sheet lead, giving a snug fit for the pipe, which should not pinch.

The delivery pipe from the injector should come into the feed pipe with an easy sweep and not into a tee. It is good practice to have as direct lines as possible on the injector.

After the boilers are tested, brush down and clean out thoroughly; fill with fresh water, and, to a 20-ton boiler, add 100 pounds soda ash. Light a wood fire in one furnace and boil out. A wood fire prevents forcing the boiler. If it is possible to get clean salt water, this should be used to boil out the boiler, but it is difficult to get at the average shipyard.

During the time that the boilers are warming up, scrape the shell and cover with two coats of fish oil to prevent rusting.

The lagging blocks should be packed closely and finished with asbestos cement. Pay particular attention to the lagging around the bottoms of the boilers. This is a slow and difficult job and is sometimes scamped. It is interesting to watch the difficulty in warming up a boiler before lagging, and the ease with which it is accomplished after it is properly lagged.

After the lagging has dried out, galvanized sheeting is fitted over it. The sheeting around the bottoms of the boilers is worth attention. In some jobs the lagging is made portable over the combustion stay ends, as this allows a frequent examination of this important part of the boiler.

After the boilers are well boiled out (the writer has found three days sufficient) they should be pumped out, thoroughly scraped and wire-brushed, and kept dry until they are required for the dock trials. Replace the manhole covers to keep out dirt.

Examine the studs securing the breeching to the shell. Sometimes they are broken, and it is nobody's business to report it. The breeching should fit closely around the boiler shell and packed with ⅛-inch asbestos sheet to prevent air leaks.

The forced draft air ducts are a favorite place to stow template sheets and other rubbish. The writer has traced

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several complaints of bad draft to template sheets blanking the air heating tubes.

The lagging on steam pipes should be portable over the flanges to permit examination of the pipe at the back of the flange, as any defect is almost sure to be found at this place.

Whistle pipes are connected directly to the boiler and a straight lead will keep them drained. This also prevents freezing in cold weather. Leading the pipe to the whistle inside the stack casing is good practice.

In installing the engines, the tail and main shafting being lined up, the rivet points on the thrust block stool are flushed and the thrust block and shaft lowered in place. The after coupling flange should be trued to the forward flange by means of steel wedges under the thrust block. Chocks are then fitted, holding down bolt holes are drilled and bolts hammered down solid. Check up the couplings for fairness after all is finished.

The engine bed plate is fitted in the same way, taking care that the rivet points are flushed. Turbine engines are fitted in a similar way, the reduction gear being first lined up and secured, then the turbine lined to the reduction gear. Alternate holding-down bolts in thrust and engine beds are machined and made a driving fit for the holes, which are reamed true to size.

On some jobs end chocks are fitted, to prevent lateral motion of the bed plates. The fitting of chocks requires skill to make a good job, but generally any man is good enough, so close attention should be paid to it. Each chock must have a good face bearing and a driving fit. Try each with a thin searcher and tap with a testing hammer.

Everything depends on the engine and shafting being in line and having a good solid foundation.

As the engines are assembled all working parts should be covered with clean canvas or burlap and securely lashed. When coupling up piston rods and other tapered fits, use mercurial ointment instead of oil. They will come adrift at any time without heating.

In the case of the auxiliary machinery the stool plate of pumps is improved by flanged edges to form a pan. Fitted with a drain pipe to the bilge, it keeps the engine room platform clean. There should be enough space around the pump for overhauling and for withdrawing the rods.

Pipe connections that are fitted fair, instead of being sprung into place, save hours of work and trouble at sea. Gaskets of well-laid pipe lines do not give any trouble.

Pipe hanging is another job that is not in demand among shipyard men. It is neglected in most yards, and nothing is more annoying than loose and vibrating pipes. Hangers should be spaced about nine feet apart.

Pumps, as delivered from the makers, have rubber gaskets and packing. Any pump that is to handle oil requires fiber gaskets and a packing designed for oil.

The electric plants now installed on new steamers give little trouble. Any conduit pipe exposed to the weather or other dampness should be painted at sleeves and outlets with black japan or enamel. Make sure that the deck fittings are really watertight and that the glass globe is cinched tight against the gasket.

If the steering engine is operated by a telemotor it is important that telemotor and valve lever are in line when the rudder is hard over, as well as when it is amidships. If it is fair when amidships and high and low when the telemotor is hard over either way, this is the cause of many stiff wheels, and also of the wheel not running back to the center.

The foundation bolts of the deck machinery should be accessible. They are sure to slack back in time, when the nuts are sure to be tight.

The dock trial is simply a preliminary running of the machinery when the ship is alongside the wharf, so that any defect may be remedied. Various speeds are run and no data are taken.

On the trial trip, have the settling tanks sounded when the bell rings that the ship is at full speed on the measured mile and again when she has finished. Take the register at the end of each mile, also pressures, temperatures, revolutions and strokes of auxiliaries. A draftsman is generally in charge of the indicating, and he will supply you with a set of cards taken on each run.

The assistant engineers can be usefully employed in observing the actual running of the machinery. Too often they depend on the shipyard crew to detect hot bearings and other defects. This is a good chance to judge an assistant's character and to act accordingly.

After the measured mile the ship proceeds on an endurance run, generally four hours. The fuel should be measured at the start and data taken every half hour, measuring the fuel at the finish of the run.

On the run back to harbor the speed of the ship on the measured mile and on the endurance run can be obtained from the captain, who will probably be interested in how the machinery ran. The data tabulated and averaged give the performance of the ship in ballast without cargo. An oil tanker generally runs her trial ballasted to the load line.

The deep-sea trial is an endurance trial after the ship is loaded and ready for sea. Twenty-four hours is a fair run. The fuel is measured and data taken as in the light trial.

The engineer's industry during the time the ship is in the shipyard will be rewarded by the absence of those small defects that are otherwise sure to crop up.

OIL FUEL.

Trouble With a Generator Set

When MARINE ENGINEERING comes aboard, the first thing I do is to look at the front page and read the advertisements. Then I turn to the letters from engineers, as I get a great many good points from them.

We have two electric sets on board. They each develop 15 kilowatts and run at 550 revolutions per minute. The engines are enclosed and are fitted with a forced system of oiling, the only one fit for such high speeds. The engines have been in charge of the chief for over three years and have never given any trouble. In that time the bearings have been taken up but once.

A few weeks ago oil began to run out of the case where the crank shafts pass through the casing, and this made things very messy. It seemed strange to me that both plants should start leaking at the same time. But if one did, why not both?

The chief thought the leak was caused by the packing wearing in the casting which was bolted to the engine bed. This casting was split so the top half could be taken off in order to take out the shaft. Where the crank shaft passed through this casting a recess had been turned and square packing put in it. The casting, bolted to the bed, formed a pocket for the oil to drip into from the crank shaft bearing.

The chief ordered me to take a man and repack the casting. I got an oiler named Girdwood. He had been chief on a tramp steamer, but got to drinking and at last had to go to oiling. He was Scotch, and when not drunk was a very good man. When I got the top half of the casting off I gave it to Girdwood and told him to go and get some new packing while I dropped off the lower half.

He looked at the packing and at the shaft, and in his

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Scotch way said that the trouble was not in it. "Where is it " I asked. "I will show you," he answered. Then he soaked out all the oil in the pocket with some waste and unbolted the lower half of the casting from the bed. There was about an inch of muck in the bottom of the casting, and Girdwood pointed to two holes drilled through the bed, leading from the pocket into the bed. These he cleaned out, as well as the casting, and put it again in place. When we started up the set there was no more leakage.

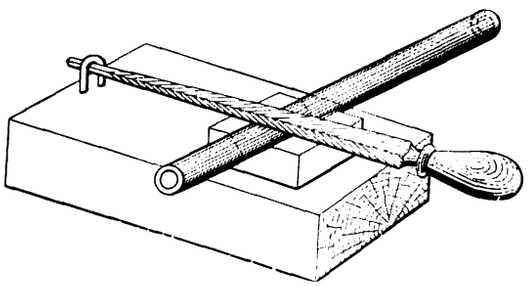
This goes to show that sometimes we do not look quite far enough for the real cause of trouble.

New Orleans, La. A. BRUCE HUNT.

Gage Glass Cutter

When it is necessary to cut a gage glass to different lengths and there is not a regular tool available for the work, a very satisfactory substitute can be made from a three-cornered file, a wire staple, and a block of wood, as shown in the accompanying sketch.

Drive the staple into the board; cut a V-block in which to rest the gage glass. Put the point of the file under the

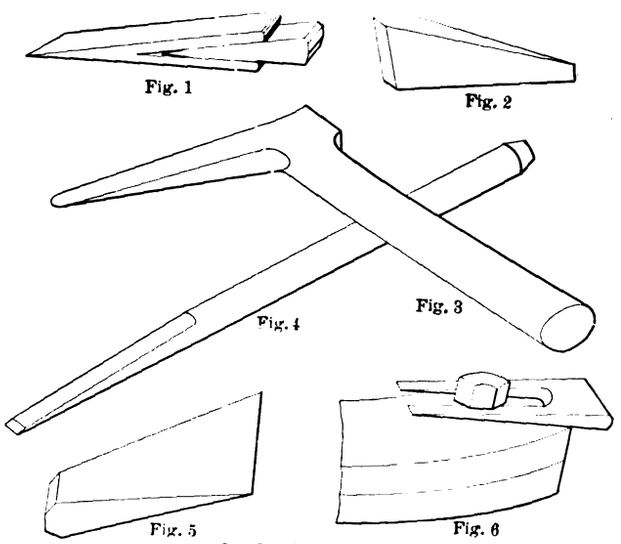


Improvised Tool for Cutting Glass Tubes

staple and press the edge of the file down on the glass and revolve the glass until it is marked. Remove the glass, heat it at the mark with a match and quickly plunge it into cold water. It will break off clean. WATER TENDER.

Useful Wedge Tools

All mechanics and engineers know the value of wedges as tools in repair work, but I have often noticed that even



Six Useful Wedges

with this knowledge many fail to provide themselves with an assortment of wedges that would make it easier to perform that work which calls for a wedge.

I have drawn herewith a few sketches showing some of the types of wedges that I have found most useful in my work and pass them along in hope that others may also find them of value. Fig. 1 is of the combination solid and split wedge for use in places where it is only possible to enter a thin wedge and not convenient to enter another thicker one without first removing the thin one. The use for such a wedge as this is obvious.

Fig. 2 shows a two-way taper with narrow starting face. Figs. 3 and 4 show handled wedges, which are useful in a wide range of work. Fig. 5 is another style of double type wedge called a fan-face wedge. Fig. 6 illustrates a slotted wedge and its handy use for removing rust-bound bolts. ASSISTANT ENGINEER.

Method for Testing Evaporator Water

Calling on a friend of mine not long ago I found him working around his evaporators. Alongside the evaporators I noticed what, upon inquiring, I found to be a quick method of testing evaporator water.

On returning to my vessel I made an outfit similar to the one I saw, and, after experimenting with it, found it

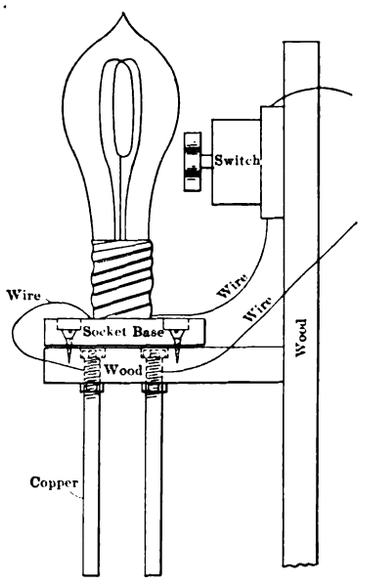


Fig. 1

to be very accurate. The only material that is required to make it is used on all electrically lighted vessels.

A porcelain electric light socket into which an electric light is screwed is fastened to a wooden base. This base may be attached to a convenient bracket. Through the base are secured two ¼-inch copper rods 3 inches long and about ⅜ inch apart, which are connected to the ship's current.

The water to be tested is poured into a glass or other receptacle made of non-conducting material. The two contacts are then inserted into the water, which, if pure, will not allow the circuit to be completed and the lamp will remain darkened. If the water contains as little as 0.3 grain of salt the globe will light. The saltier the water the brighter the light will burn. The sketch, Fig. 1, illustrates the method used to make this convenient bit of apparatus. "IDEAL."

Dirt in a boiler or in the bearings of your engine is as bad for both as is dirt in your own system. You would not drink dirty water. Why give it to your boiler to drink?

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

De-aeration of Boiler Feed Water

Q. (1031).—The trend of modern marine engineering practice is towards the elimination as much as possible of all air from the boiler feed water. It occurs to me that several years ago I read an account of a boiler explosion which was then attributed to the entire lack of air in the boiler water. So far as my memory serves me the instance was a tug boat which had foundered outside the mouth of the River Scheldt. The vessel had lain at the bottom of the sea for some time and was subsequently raised; then men were sent on board to raise steam on the boiler, the original water still remaining in the boiler. On the next day, before the vessel started to leave the spot, she blew up.

So far as I can recollect, the cause of the explosion was assigned to the supposition that the air which had been held in the boiler water had combined with the metal of the boiler shell to form ferrous oxide, leaving the water entirely de-aerated. Then after the fires had been set away some hours the water, having been heated beyond the boiling point, had then suddenly passed into steam with explosive force, shattering the boiler and vessel.

I can find no data supporting this view, and I shall be glad if you have any information bearing on the subject. W. I. E.

A. (1031).—To the writer it would seem that whether the boiler contained merely water and its vapor, or water, its vapor and the slight amount of air ordinarily present mattered little. An engineer would naturally remove some of the water before getting up steam, and doing this would be likely to cause air to combine with the water and occupy the steam space together with water vapor.

The statement that the boiling water burst suddenly into steam would seem to indicate that "retarded ebullition" was blamed for the explosion, i. e., the water was superheated about the heating surface and burst instantaneously. This, according to Stromeyer, is impossible in a closed boiler (see Stromeyer's "Marine Boiler Management," 1914, page 57, which volume gives some interesting cases of boiler corrosion).

A plausible explanation of the case cited is that the stayrods or shell had corroded locally; a safety valve may not have been in working order. This would provide ideal conditions for an explosion. Air or cold salt water separately are not as bad corrosive agents as the two in combination.

Another theory might be based on the likelihood of an insulating scale being formed over some part of the furnace or combustion chamber. This would allow that portion to be overheated, causing it to buckle and rupture.

The illustration given by the questioner is a most interesting one. It would be well to give more publicity to boiler accidents which have occurred in the past. In England the Institute of Marine Engineers, the Board of Trade and the classification societies take up all accidents and assign causes.

Lock Nuts

Q. (1024).—Would you kindly, in your next issue, settle an argument regarding the proper position of lock nuts. I have always placed them as shown in Fig. 1, but *A* tells me that when a lock nut is tightened the stress on the large nut, Fig. 1, will be entirely removed. I have made up my theory as to what takes place when the nuts are tightened, but would be very thankful if you would settle the argument. G. J. L.

A. (1024).—*A* is right; but it is undeniable that lock nuts are commonly placed as in Fig. 1, which illustrates their action. Fig. 2 shows the proper method of applying them. Now the purpose of using two nuts is to prevent vibration from causing them to slack off. Unless the outer nut is screwed up enough to take a good portion of the load from the inner one it will tend to slacken up and thereby be of no service. If the inside nut is screwed up fairly tight and the outer made very tight, the effect shown in Fig. 1 will be produced. Considering the threads of this bolt, it is seen that the inner nut acts against the outer, and therefore the latter takes not only the bolt load but also that due to the inner one. Hence the outer nut should be the thicker. Due to the trouble of screwing a nut less than $0.7d$, the standard wrench thickness, as well as through force of habit, the thinner nut is rarely placed in its right position. To obviate this tendency it is advisable to make both nuts of the same thickness, say $\frac{3}{4}d$. Lock nuts are used for auxiliary machinery, the valve gear, link rods and levers of reversing gear, thrust shoes, etc.

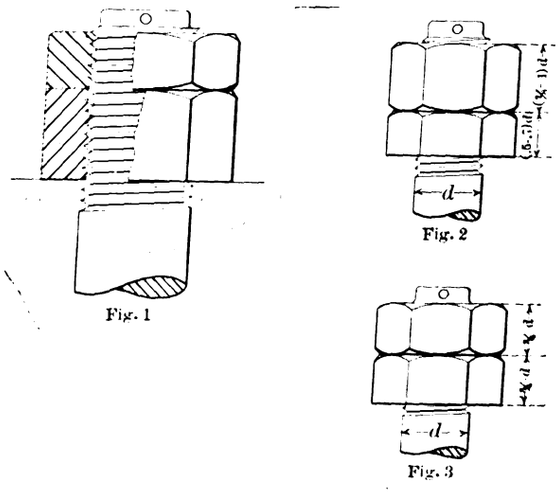

Fig. 1 Fig. 2 Fig. 3

Sketches Showing Proper and Improper Positions of Lock Nuts

When you order spares and they come aboard, take time to measure them up with great care. A little "out" can be corrected in a few moments in the shop, while it may take hours to make the fit at sea. It will pay, whenever possible, to do the inspecting of spares in the shop where they are made. More care will be taken if the foreman knows that someone is to inspect the work.

A piece of emery cloth thrown on top of a bunch of waste in a drawer or closet is a sight often seen. That is as poor a combination as anyone can make, yet it would be a safe bet that aboard your ship or in your shop this absurd condition is to be found time and time again. Take a look, Chief, and you, Mr. Foreman, right now and see if it is not so.

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Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

2,338 VESSELS BUILT IN 1919 BY PRIVATE AMERICAN YARDS

All Were for American Owners, Aggregating 4,213,891 Gross Tons — 52 Vessels, of 44,250 Gross Tons, Built for Foreign Owners — Big Increase Over 1918 figures

The Bureau of Navigation, Department of Commerce, reports that during the calendar year 1919 private American shipyards built 2,338 merchant vessels of 4,213,891 gross tons, which have been officially numbered for American shipowners, and accordingly are now in trade or about to engage in trade. American shipbuilders also built 25 vessels of 44,250 gross tons for foreign owners, making a total output of 2,363 vessels of 4,258,141 gross tons for the 12 months.

During the calendar year 1918 the corresponding output was 1,834 vessels of 2,622,588 gross tons for American and 48 vessels of 98,693 gross tons for foreign owners, a total of 1,882 vessels of 2,721,281 gross tons.

Of the 1919 output, 916 vessels of 3,569,824 gross tons were built of steel, an increase of 434 vessels and 1,699,465 gross tons over 1918.

The following details of vessels built and officially numbered in the United States in 1919 are reported by the Bureau of Navigation:

Kinds	Atlantic and Gulf		Pacific		Great Lakes		Western Rivers		Total	
Wood	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons
Sailing	97	102,550	6	9,736	1	1,946	....	....	104	114,241
Steam	119	178,607	85	221,952	34	9,732	15	1,886	253	412,177
Gas	381	27,245	294	27,584	66	1,151	83	1,506	824	57,486
Unrigged	136	52,028	68	6,852	8	785	29	498	241	60,163
Total	733	360,439	453	266,124	109	13,614	127	3,890	1,422	644,067
Metal										
Sailing	4	6,653	....	.....	....	.....	....	....	4	6,653
Steam	*394	1,848,230	197	1,174,743	212	508,574	5	1,507	808	3,533,054
Gas	12	4,877	....	.....	7	74	2	44	21	4,995
Unrigged	†41	12,142	1	348	‡38	10,969	3	1,663	83	25,122
Total	451	1,871,902	198	1,175,091	257	519,617	10	3,214	916	3,569,824
Totals										
Sailing	101	109,212	6	9,736	1	1,946	....	....	108	120,894
Steam	513	2,026,837	282	1,396,695	246	518,306	20	3,393	1,061	3,945,231
Gas	393	32,122	294	27,584	73	1,225	85	1,550	845	62,481
Unrigged	177	64,170	69	7,200	46	11,754	32	2,161	324	85,285
Grand total	1,184	2,232,341	651	1,441,215	366	533,231	137	7,104	2,338	4,213,891

* Includes 4 vessels of 10,635 tons built of reinforced concrete. † Includes 11 vessels of 3,356 gross tons built of reinforced concrete. ‡ Includes 7 vessels of 2,133 gross tons built of reinforced concrete.

As compared with the foregoing table the following are the details of the vessels built and officially numbered in the United States in 1918:

Kinds	Atlantic and Gulf		Pacific		Great Lakes		Western Rivers		Total	
Wood	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons	No.	Gross Tons
Sailing	77	59,428	19	14,325	....	.....	....	....	96	73,753
Steam	108	183,550	128	324,351	13	3,540	15	1,523	264	512,964
Gas	242	24,425	309	50,048	43	660	66	1,223	660	76,356
Unrigged	209	78,303	67	7,596	25	2,550	31	707	332	89,156
Total	636	345,706	523	396,920	81	6,750	112	3,453	1,352	752,229
Steel										
Sailing	4	4,092	....	.....	....	.....	....	....	4	4,092
Steam	132	601,698	*155	871,561	177	389,853	2	335	466	1,863,477
Gas	3	550	....	.....	....	.....	‡4	52	7	602
Unrigged	2	1,340	†1	325	2	553	....	....	5	2,218
Total	141	607,680	156	871,886	179	390,406	6	387	482	1,870,359
Totals										
Sailing	81	63,520	19	14,325	....	.....	....	....	100	77,845
Steam	240	785,248	283	1,195,912	190	393,393	17	1,858	730	2,376,411
Gas	245	24,975	309	50,048	43	660	70	1,275	667	76,958
Unrigged	211	79,643	68	7,921	27	3,103	31	707	337	91,374
Grand total	777	953,386	679	1,268,206	260	397,156	118	3,840	1,834	2,622,588

* One vessel of 3,427 gross tons built of concrete. † One vessel of 325 gross tons built of concrete. ‡ One vessel of 11 gross tons built of concrete.

MAKES TONNAGE RECORD

American Ship Building Company Has Big Year

The twentieth annual report of the American Ship Building Company, of Cleveland, for the last fiscal year, shows in a concise but illuminating way the enormous amount of work accomplished by the concern and its subsidiaries, the Detroit Ship Building Company, of Detroit; the Chicago Ship Building Company, of Chicago; the Superior Ship Building Company, of Superior, Wis.; the Buffalo Dry Dock Company, and the Milwaukee Dry Dock Company.

The record shows the greatest production of tonnage and largest volume of business of any year since the formation of the company, although with the tonnage two and a half times that of the previous year the earnings were somewhat less.

During the fiscal year, 109 ocean cargo ships, of 422,800 gross tons carrying capacity, were completed and delivered. The company has yet to complete and deliver to the United States Shipping Board Emergency Fleet Corporation sixty-three ocean cargo ships, of 255,900 gross tons carrying capacity. Construction has been delayed by changes ordered by the Fleet Corporation and restrictions imposed limiting the hours of labor. No penalties, however, will accrue through delays in delivery of these ships.

During the year additional plant equipment and other facilities were provided at a cost of $4,018,532.63, in addition to $159,313.80 expended for housing facilities. The company also, during the fiscal year, took $6,150,000 in Liberty Loan bonds, to which the employees added $2,393,500 in subscriptions.

The financial statement shows assets of $152,584,436.89 on a capitalization of $30,000,000, with $15,117,012.41 reserve liabilities, and a surplus of $11,856,087.55.

The officers of the company are: M. E. Farr, president; James E. Davidson, first vice-president; Ora J. Fish, second vice-president and secretary; Alfred G. Smith, third vice-president; W. H. Gerhauser, fourth vice-president; Arthur G. Potter, comptroller; John S. Gorman, treasurer and assistant secretary.

A New Staatendam

The Holland-America Line has begun the building of a new *Staatendam*, which will replace in the Holland-America Line passenger service a vessel of the same name sunk by a German submarine during the war after it had been taken over by the British.

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CUNARD LINE PLANS

More Than 500,000 Tons to Be Added To Allied Fleets

While no information regarding their structural features has been received, some details of the shipbuilding programme of the Cunard and allied interests have reached here from their home office in Liverpool, and show that more than 500,000 tons of shipping of the intermediate or passenger and cargo type will be added to their equipment when present plans are carried out.

The *Cameronia*, recently launched, was the first of five vessels of the 14,700-ton type now being built in British yards. At the Fairfield Shipbuilding & Engineering Company's plant, Glasgow, two, which are to be named the *Caledonia* and *Transylvania*, are being constructed for the Anchor Line, while Alex. Stephens & Company, Glasgow, are building the *California* and *Tuscania*. These ships are of the intermediate type, having first class accommodations for 275 passengers, 359 second and 1,184 in third class. They are 550 feet long.

The Anchor Line expects that the *Cameronia* will be available for operation late in the spring. She is to be placed on the run between New York, Londonderry and Glasgow.

Under construction at this time the Cunard and allied lines have a total of 34 ships of 389,000 gross tons. The Cunard has 11 ships of 174,000 gross tons building at the various shipyards in the United Kingdom. Vickers, at Barrow-in-Furness, is building two of these, the *Scythia* and *Aubonia*, and it is expected that they will be delivered late in the spring. None of the vessels under construction is of the size of the *Mauretania* and other super-liners. The first desire of the Cunard Line is to replace the losses of the intermediate types, which carry both passengers and cargo.

Of the allied lines, the Anchor-Donaldson is building at the Fairfield yards two 10,000-ton ships which are to be devoted to the Canadian services. The Anchor-Brocklebank has fourteen vessels, aggregating 105,000 tons, on the ways, while two 10,000-ton ships designed for the Indian services of the Anchor Line are under construction at the Stephens yards.

Contracts have been placed for the building of more than 100,000 additional tons of ships, the keels of which have not been laid.

Liners for West Coast

Seattle, Wash., headquarters of the South American Pacific line, has received unofficial advices that two steel freighters for the West Coast service have been ordered from British builders. One, according to the report, is of 7,000 deadweight tons, and will be built by Robert Thompson & Co., Ltd., of Sunderland, Eng., and the other, of 6,700 tons, will come from the Clyde Ship & Engine Company, of Glasgow.

ORDER GEARED TURBINES

New Steamers Will Be Equipped by Westinghouse Company

The Westinghouse Electric and Manufacturing Company announces that the Merchant Shipbuilding Corporation has awarded to it the contracts for the propelling machinery for two new ships being built at the Company's Chester yards for the Shawmut Steamship Company. These ships, which are designed for general cargo service, will be of about 10,000 dead weight tonnage, and are to have a speed of thirteen knots. Propelling equipment of each will consist of a 4200-shaft-horsepower cross-compound Westinghouse turbines, of the latest type, which will drive the single propeller through double-reduction gears. An oil-relay governor will be provided which will prevent the propeller from racing, even in heavy seas, but will at no time shut the turbines down. As there will be two separate turbines, high and low pressure, and either can be operated independently in an emergency, the danger of crippling the ship by an accident to the machinery is very remote. The gears are to be of the floating-frame type, which automatically keep in alignment in spite of errors or changes in adjustment that would be disastrous to rigid gears.

The main condensing equipment is of Westinghouse make, including the condensers, Leblanc air ejectors and condensate pumps. The system is designed to maintain a vacuum of greater than twenty-eight inches in 70° degrees sea water.

There are now in commission, or being built, over 250 ships equipped with Westinghouse geared turbines.

Five Repair Contracts

Contracts for the repair of five Shipping Board steamers have been distributed among as many yards. Announcement has been made that the *Oscoda* would go to the Vulcan Iron Works, Jersey City; the *Western City* to Tebo's Yacht Basin, Brooklyn; the *Lorain* to Robins Dry Dock & Repair Company, Brooklyn; the *Lake George* to the Marine Iron Works, Brooklyn, and the *Lake Fackler* to the Arthur Tickle Engineering Company, Brooklyn.

Brazil Needs Ships

An American correspondent recently in Rio de Janeiro, Brazil, had an interview with Dr. Cincinnato Braza, Minister of Agriculture, Industry and Commerce, in which the Doctor mentioned many lines in which it would be necessary for Brazil to spend an enormous amount of money in the near future. One part of the interview quoted the Doctor as stating: "During the coming generation we shall need at least 500,000 tons of river and ocean steamships."

TO BUILD 14 SHIPS

National Shipbuilding Company Has Big Job on Hand

Further details of the National Shipbuilding Company's contracts for construction for French interests, mentioned in SHIPS AND SHIPPING on December 19, have become available, and show that 14 vessels are involved in the contracts, which will be carried out at the Three Rivers, Quebec, yards of the company. It is stated that construction prices are on the basis of $120 per ton, deadweight, for six 7,200-ton boats; $180 for six 4,200-tonners; $185 for one 3,250-tonner, and $185 for one 6,500-ton oil tanker. All the vessels, it is reported, are to be built on the Isherwood system. The dimensions and specifications of the vessels are given as follows:

7,200-ton Steamers—380 feet long, 52 feet beam, 27 feet 4 inches depth, 23 feet 3 inches draft, 2 decks, poop, bridge and forecastle; triple expansion engines, cylinders 26, 43 and 71 inches diameter, 48-inch stroke, 3 boilers, 180 pounds pressure, 15 feet 6 inches by 11 feet 6 inches; trial speed, loaded, 11 knots.

4,200-ton Steamers—310 feet long, 45 feet beam, 22 feet 4½ inches depth, 19 feet draft, single deck, poop, bridge and forecastle; triple expansion engines, cylinders 23, 39 and 64 inches diameter, 42-inch stroke, 3 boilers, 180 pounds pressure, 13 feet by 10 feet 9 inches; trial speed 11 knots.

3,250-ton Steamer—280 feet long, 42 feet beam, 20 feet 9 inches depth, 18 feet draft; single deck; triple expansion engines, cylinders 21, 34 and 57 inches diameter, 39-inch strike, 2 boilers, 180 pounds pressure, 14 feet 6 inches by 11 feet; trial speed, loaded, 10½ knots.

6,500-ton Tanker—380 feet long, 52 feet beam, 28 feet 3 inches depth, 22 feet 9 inches draft, poop, bridge and forecastle; triple expansion engines, located aft, cylinders 27, 44 and 73 inches diameter, 48-inch stroke, 3 boilers, 180 pounds pressure; trial speed 11½ knots.

It is possible that the smallest of these vessels may be built in the Violet, La., yards of the company.

Matson Plans Big Steamer

The Matson Navigation Company of San Francisco has just laid the keels for two 14,000-ton freight carriers. The work will be done at the Moore Shipping Company's plant at Oakland. The boats will be operated between San Francisco and Honolulu. They will be 497 feet overall, 480 feet between perpendiculars, 62 feet beam, 42 feet deep to the shelter deck, and will carry 14,000 tons of sugar.

According to William Roth, vice-president and general manager of the Matson Company, this is only an initial contract. Officials and directors of the company are now working out details of the specifications for a huge steamer, which will be the largest, fastest and most palatial passenger liner on the Pacific. The plans will be submitted to the local builders in the immediate future.

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1919'S LAKE SHIPBUILDING

Out of 217 Vessels Not One Was For Local Use

Shipyards on the Great Lakes built 217 vessels during 1919, 188 steamers and 29 tugs, all for the Emergency Fleet Corporation. Although the Lake yards were kept busy the entire season, not a boat was built for the Lakes, all being sent to the coast for salt water service. Fifty-seven steamers and 19 tugs ordered for 1919 delivery were not completed, but most of these will be ready to sail in the spring.

The American Ship Building Company, of Cleveland, built 93 of the steamers completed during the year. The Great Lakes Engineering Works Company, of Detroit, turned out 37, the Toledo Shipbuilding Company built 12, the Saginaw Shipbuilding Company 8, the Manitowoc Shipbuilding Company 12, the McDougall-Duluth Shipbuilding Company, of Duluth, 17, and the Globe Shipbuilding Company, of Duluth, 9 steamers.

The American Ship Building Company now has uncompleted orders for 20 boats. The Great Lakes Engineering Works will build for delivery early next season 7, the Toledo Shipbuilding Company 4, the Manitowoc Shipbuilding Company 7, the Saginaw Shipbuilding Company 6, the McDougall-Duluth Shipbuilding Company 8, and the Globe Shipbuilding Company 5.

Lake shipyards have already received a number of additional orders for boat for salt-water service to be built during 1920.

ADDING TO BIG FLEET

Peninsular and Oriental Company Orders Five Liners

In connection with the recent report of Lord Inchcape, President of the Peninsular and Oriental Steam Navigation Company, it is reported that an order has been placed with Harland & Wolff for five liners of the B class for the Australian emigrant and cargo service, via the Cape. These vessels will be somewhat larger than the previous ships of this class, and will be about 13,800 tons each.

The construction of the first of the ships has been begun at Belfast.

Groton Yard to Continue

P. LeRoy Harwood, receiver of the Groton Iron Works, denies the rumors that the yard is to be discontinued. Following a conference with E. A. Morse, president of the company, a day or two ago, Mr. Harwood announced that there was no truth in the current rumors that the yard was about to close.

"The yard will remain a permanent industry," said Mr. Harwood, "and the year 1920 will not see the dissolution of the plant, as some people have undertaken to state."

BUSINESS NOTES

Westinghouse opportunities for technical graduates are very thoroughly explained in an illustrated pamphlet bearing that title, recently issued by the Westinghouse Electric & Manufacturing Company. In the book is a list of prominent Westinghouse men who entered the company as graduate students, as well as a complete list of schools from which over 5,000 students have entered the employ of the company. Copies of the booklet will be sent to anyone interested, on application to the educational department of the company at East Pittsburgh, Pa.

The Clinton Wright Wire Company, a $16,000,000 corporation of Worcester, Mass., has acquired the Wickwire Steel Company, of Buffalo. The new concern will be known as the Wickwire Spencer Steel Corporation. The principal officers of the corporation will be: President, T. Harry Wickwire, Buffalo; vice-president, Ward A. Wickwire, Buffalo; vice-president and general manager, George M. Thompson, president of the Clinton Wright Wire Company. The headquarters will remain in Worcester.

Under a recent contract received by the Keller Pneumatic Tool Company, of Chicago, for supplying United States Navy yards with all their requirements in pneumatic riveters, chippers, scaling hammers and holders-on for the fiscal year, the first order was for 3,496 tools, divided as follows: Riveters, 881; chippers, 1,428; scalers, 896; holders-on, 291. Additions since the original order was placed bring the present total to approximately 4,000 Keller-Master Tools. With customary "Keller service" promptness, the greater portion of the tools specified were shipped on receipt of confirmation of the order.

Developments of the Ohio Body & Blower Company have made necessary taking over three plants from the older company, the Ohio Blower Company. Plant No. 1 is the three-story plant on Perkins avenue, Cleveland, which served for five years as the home of the company. Plant No. 2 is the new plant housing the home offices, on Detroit avenue, on the West Side of the same city. Plant No. 3 is the modern foundry at Orrville, Ohio, which operates exclusively on the Ohio Blower Company work. These three plants provide employment for more than 600 workers in 150,000 square feet of floor space. Spring will see these figures increased to 1,000 workers and 350,000 square feet of floor space by the completion of another unit of Plant No. 2, to be devoted to the building of closed bodies. The paid-in capital of the Ohio Body and Blower Company affords ample resources for further expansion. The change will not affect the personnel of the management. The officers of the older company, Mr. D. K. Swartwout, president, and Mr. H. H. Lind, vice-president, assume the same offices in the new corporation.

A. H. Dinshaw & Co., of Bombay, B. E. I., importers of machinery, hardware, etc., send word to American manufacturers, through MARINE ENGINEERING, that they are interested in woodworking machines, lathes, drilling machines, pumps, oil engines, steam engines, portable steam engines, boilers, grinding mills, oat-crushers, cranes, ice-making plants, hydraulic presses, pumps, air-compressors, etc. Also in mill stores, gin stores, and general engineering sundries.

The New York branch of the American Society of Marine Draftsmen held its annual banquet at the Marlborough Hotel, New York City, on Saturday, January 17, 1920. The principal speakers were: President, Clarence C. Jacobson, of Branch 23; National President A. H. Haag, Mr. J. E. Burke, of MARINE ENGINEERING; Mr. Sydney Swan. The subjects discussed were mainly with relation to the importance of the work of the draftsmen during the recently past emergency, and in connection with present and future American merchant marine. New York Branch, No. 23, is now holding regular meetings on the second Thursday of each month at the Engineer Societies building, West Thirty-ninth street, and some very interesting and important papers are being read and discussed. These meetings are of exceptional value to all draftsmen in the locality, and those men not already members of Branch 23 are urged to attend the meetings. A drive for new members is ot be started soon.

The Sizer Forge Company, of Buffalo, announces the opening of a district sales office at 459 Book Building, Detroit, with Mr. L. D. Stanton in charge.

Russel W. Stovel, who has had wide experience with central power station and steam railroad electrification problems, has been appointed as a consulting engineer by Westinghouse, Church, Kerr & Co., Inc., of 37 Wall street, New York.

The Pittsburgh Screw and Bolt Company has opened branch offices at 50 East Forty-second street, New York, in charge of Mr. J. Allen Dillon.

Thomas Christensen and James V. Schraig have organized the East Coast Electrical Supply Company, at 399 Pearl street, corner Vandewater street, New York.

The Black & Decker Manufacturing Company, of Baltimore, has opened an additional office on the Pacific Coast, at 201 Maynard Building, Seattle, Wash. The office is in charge of Mr. A. E. Nordwall, who will have charge of the distribution of Black & Decker products in the State of Washington.

Fairbanks, Morse & Co., of Chicago, will soon start the erection in Beloit, Wis., of the most modern foundry in the world. It will equal in size and output any factory on the globe. This structure will, when completed, be 900 feet long, 550 feet wide, and will contain 495,000 square feet of floor space. The build-

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ing, including storage of flasks, iron, sand, etc., which will also be under the roof, will cover eleven acres of ground. It will be directly to the north of the present power house, bordering the River Road. The completed structure will have an ultimate capacity of 300 to 400 tons of gray iron daily, and means the addition of 3,000 men to the working force of the already large plant.

The business of the Carlson-Wenstrom Company and the Carwen Steel Tool Company, Erie avenue and Richmond street, Philadelphia, will be continued by A. H. & F. H. Lippincott, manufacturers of screw machine products who have purchased the assets of these two companies and under their direct supervision will manufacture the Carwen Dynamic Balancing Machine, and all classes of special machinery in conjunction with their screw machine products. Mr. Joseph A. Ganster will be associated with the corporation as director and works manager, and Mr. Jacob Lundgren as engineer. The business will be conducted under the corporate name of Lippincott-Carwen Corporation.

The Diamond Power Specialty Company, Detroit, Mich., announces the appointment of Michael J. Stack as assistant marine manager. Mr. Stack's headquarters will be in the office of the company's marine manager, F. W. Leahy, 32 Broadway, Room 1611, New York City.

The Material Handling Machinery Manufacturers' Association, of which Calvin Tomkins, formerly Dock Commissioner of New York City, is president, has issued a prospectus, entitled "The Right Arm of Industry," which shows the successful record made by the association in its life of less than a year. The office of the association is at 35 West Thirty-ninth street, New York City, and its membership includes nearly every concern of prominence in the country in the line of material-handling machinery.

The Chicago Pneumatic Tool Company announces the appointment of Mr. Edward A. Woodworth and Mr. C. E. Laverenz as special railroad representatives attached to the staff of the Manager of the western railroad sales, with headquarters at Fisher Building, Chicago, Ill.

A contract recently signed between the Fairbanks Company, Broome and Lafayette streets, New York, and the Lincoln Electric Company, of Cleveland, Ohio, gives the Fairbanks Company the exclusive distribution of Lincoln electric motors for industrial applications. This line includes alternating current motors for two-phase and three-phase circuits, in capacities from one-half to 500-horsepower. For all commercial voltages and frequencies, and direct current motors, from one-half to 150-horsepower. The Fairbanks Company will also co-operate with the various Lincoln district offices in connection with the sale of the manufacturer's other products.

Hydraulic Variable Speed Gears

At the recent Shipping, Engineering and Machinery Exhibition held in Olympia appeared the hydraulic variable speed gears produced by the Variable Speed Gears, Ltd., of Westminster.

These gears are for transmitting rotary power at variable speeds in either direction without stops or abrupt graduations, while the source of power rotates in one direction only and at a constant speed.

They consist of an hydraulic pump and an hydraulic motor. The former is driven at a constant speed in one direction and by means of varying the stroke of its pistons the rate of flow of the fluid delivered to the motor can be adjusted from zero to the full capacity of the pump. The motor having a fixed stroke, its speed depends upon the quantity of fluid delivered by the pump. By suitably controlling the stroke of the pump, the motor may be caused to rotate at any speed from that of the pump to zero. Moreover, the stroke-controlling mechanism is further arranged to alter the relative positions of the pistons and consequently to reverse the direction of flow of the fluid, with the result that the motor can be run in the backward position with the same range of speeds as in the forward position.

The pump can also be used alone as a variable delivery pump, in combination with a single-acting or double-acting ram.

Application to Ship Steering Gear

The exhibit at Olympia includes a working model of a ship's steering gear, Fig. 1, as fitted in vessels of the Cunard Line. This installation includes a variable delivery pump, driven by a shunt-wound, non-reversing electric motor, supplying oil to one or other of a pair of rams in accordance with the direction

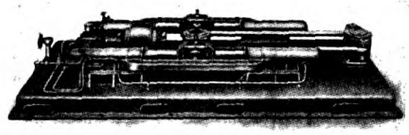

Fig. 1.—Electric Hydraulic Steering Gear Operated by Williams Janney Variable Delivery Pump

in which it is desired to move the rudder. Automatic cut-off gear is provided at the pump for determining the amount of oil to be supplied for any desired position of the rudder. Relief valves are provided on the cylinders so that in the event of the rudder being struck by a heavy sea the oil is by-passed from one cylinder to the other and the stern of the ship relieved of shock. This by-passing of the oil allows the rams to move, and at their movement, by setting in motion the control gear on the pump, puts sufficient stroke on the pistons to restore the rudder automatically to its former position.

The control of the gear is by means of an hydraulic telemotor from the bridge, and a mechanical steering pedestal is provided on the poop deck for use when steering from the aft position.

For operating the rudder by hand two teak wheels are provided, and these operate a quadrant forming part of the tiller, through worm and spur gearing, which gives the necessary reduction between the steering wheels and the rudder post.

The entire absence of mechanical gearing between the electric motor and rudder post, together with the direct connection between the rams and tiller, makes this type of steering gear quite noiseless.

Yard Capstan

A standard type of yard capstan, as shown in Fig. 2, was also exhibited. In this an electric motor is used for driving the capstan spindle through a totally

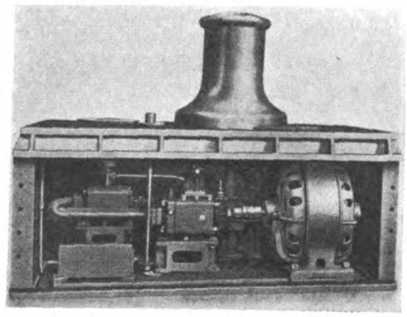

Fig. 2.—Standard Yard Capstan with Variable Speed Gear Installed

inclosed worm gear. By reason of the high starting torque obtainable, coupled with an infinitely slow speed on the capstan, a steady pull equal to three times the normal load can be obtained on the rope, while any speed from zero up to the maximum speed of the capstan can be got without stops or abrupt graduations. The provision of relief valves in the variable speed gear itself protects the rope from breakage.

McMILLAN'S NEW VESSEL

Arctic Explorer Will Start North In July Next Year

Donald B. McMillan, the Arctic explorer, has contracted with Hodgdon Brothers, of East Boothbay, Me., for an auxiliary knockabout schooner of 55 gross tons. The craft will be named *Bowdoin*, for Bowdoin College. Her principal dimensions will be 85 feet long over all, 22 feet beam and 9 feet 7 inches draft. A 45-horsepower Fairbanks-Morse kerosene oil engine will furnish auxiliary power. The cruising radius will be 3,000 miles and tank capacity 2,000 gallons.

The *Bowdoin* is designed especially for Arctic exploration. Her owner intends to start North in July, 1921, on a two-years' voyage. He was with Peary when the latter reached the North Pole in 1909.

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SCHWAB FAVORS SUBSIDY

Says Workmen Should Have Representatives in Business

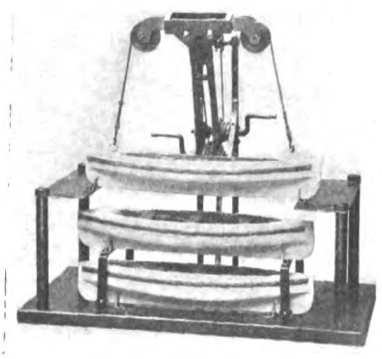
Charles M. Schwab, President of the Bethlehem Steel Corporation, at a recent dinner of the Rubber Association, said that the American merchant marine cannot be developed unless shipping laws are revised to allow private capital a profit. He intimated that subsidy for American ships would be desirable, adding that before business can be re-established on a firm basis the present period of extravagance must be curbed. He added that most of the cost of manufactured articles was for labor, and regarded as the principal industrial problem management, disposition and encouragement of labor.

"Treat labor well," he urged, "make your workmen partners; allow them to have representatives in the conduct of business, and do not permit agitators to tell you what to do. Then establish your business on a solid basis."

New T-Head Boat Davit

A new boat davit has recently been invented by G. Torrie, of London, The object of this invention is to provide means for lowering and raising ships' boats by means of a single davit placed on a platform on the inboard-side above and projecting over the boats.

The davit is supported at about 3 feet from the bottom end and can be swung inboard and outboard as desired by means of worm gear fixed at the bottom end of the davit, or by ropes led to winding gear. There are two single falls, which engage the hooks in the



New "T" Head Boat Davit

boats at points about 9 feet from the bow and stern. The falls are led up at a slope of about 3 feet out of the perpendicular, around swiveling wheels coupled together by means of a hollow shaft, through which the falls pass down to the winch gear, fixed on the davit or deck. Hydraulic, steam, electric or hand power may be used to operate the hoists, as desired.

A seven-foot "T" head davit would probably be found suitable for a 24- or 28-foot boat, but this length might be altered for different types of life boats.

It is claimed by the inventor that the davit has the following advantages:

Owing to the use of two single falls, there can be no danger of the falls getting entangled. The boat can be lowered on an even keel without danger of tipping up. It is not necessary to swing the boat over the ship's side before loading, but while the boat is at rest on the deck the passengers can take their places with greater safety and a considerable saving of time in launching.

In the event of the ship having a heavy list, the boats can still be lowered from the high side. The boats could be filled up and lowered faster, and not so many men required for launching purposes per boat. The davit can be adapted to one boat or any number up to five boats per station. Owing to the construction of the "T" head, no guy ropes are required for keeping the boat parallel with the ship's side

American-Made Tracing Cloth

The National Tracing Cloth Company of Saylesville, R. I., after a great many years' experience in the manufacture of cloth, has produced the first, and, so far, the only American-made tracing cloth. For nine years special research work has been carried on to bring the manufactured product of this country up to the required standard.

The yarn from which the cloth is made is selected from long staple cotton, especially carded and combed to eliminate all foreign particles that would be detrimental to the clearness of the finished article, as well as to secure the high tensile strength necessary to the best grades of tracing cloth.

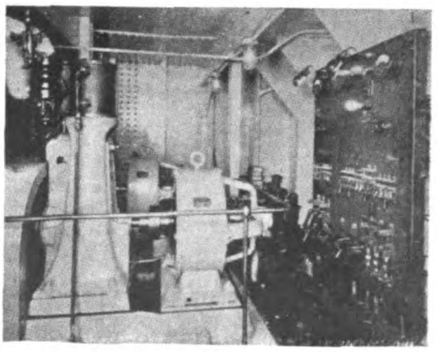
Samples of this cloth, backed by the strongest possible guarantee, will be supplied to anyone who may wish to personally test it under working conditions in his own office.

New Marine Lighting Outfit

A new line of engine-driven marine lighting generators, designed especially to insure reliability of operation, has recently been developed by the Westinghouse Electric and Manufacturing Company. The sets range in size from 2 to 50 kilowatts, and each consists of a steam engine coupled to a generator, the whole being mounted on a bed-plate so as to form a compact unit. The 15 kilowatt size, shown in the illustration, is six feet long, three feet wide, five feet high and weighs about 3,300 pounds.

The engine used in these sets is manufactured by the Clarage Fan Company. It is of the single-cylinder, vertically enclosed V-type with automatic lubrication. It can be supplied for operation on steam pressures of from 80 to 250 pounds, and is suitable for either condensing or non-condensing service. The engine speed ranges from 500 revolutions per minute in the smallest sizes to 350 revolutions per minute in the largest.

The generator, while in general of standard Westinghouse construction, is especially designed for marine service. The bearings are arranged so that proper lubrication is assured regardless of the tossing of the vessel. The windings are especially insulated to protect them from salt and dampness. Metal



Two 15-Kilowatt Westinghouse Generators on S. S. *Britto*

parts subject to corrosion are made of non-corroding alloys. A special feature of these generators is their freedom from sparking at the commutator, even under heavy overloads. They are supplied for either 125 or 250 volts, direct current, and for either two- or three-wire systems.

PERSONALS

A. G. Gibbons, formerly superintendent of the department of tools and supplies, Winslow Brothers Company, Chicago, has now become affiliated with the Wetmore Reamer Comapny, 210 Sycamore street, Milwaukee, Wis., as production engineer.

A. H. Ashford has opened a sales office and warehouse for the Western Electric Company at 334 East Bay street, Jacksonville, Fla. F. H. Van Gorder has been appointed manager of the Newark store of the company.

The Ingersoll-Rand Company has established a new office in the Sam Houston Life Building, Dallas, Tex., under the management of R. H. Brown, Jr.

Charles Cory & Son, Inc., with main office and factory at 200 Hudson street, New York, has opened branch offices at 207 Market street, Philadelphia, and at 83 Columbia street, Seattle, Wash.

The Lidgerwood Manufacturing Company, New York, has opened a branch office under the management of R. S. Hutchinson in the Hammond Building, Detroit, Mich.

A. C. Hidalgo has been made special South American representative of the Worthington Manufacturing Corporation, a subsidiary of the American Steel Export Company. J. C. Devereaux, chief city salesman of the American Steel Export Company, has taken over the sales for the Worthington Manufacturing Corporation in this district.

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RECLAIMING RIVETS

Two Machines of Value to Shipyards

One problem encountered by the salvage department of shipyards has been the reclamation of rivets, bolts and nuts which have accumulated rapidly and in many cases have been scrapped because of the expense of making them fit for use again. Many devices have been developed in various yards to reduce this salvage expense, and two types of machines produced by the International Reclaiming Company, installed in the shops of the New York Shipbuilding Corporation, Camden, N. J., are particularly interesting. The machines have been placed on the market by Nelson, Lodge & Snyder, Widener Building, Philadelphia, Penn.

One machine, consisting of a worm and double-gear, motor-driven table, as shown in Fig. 1, is used for sorting rivets and bolts according to length. The table is made up of cast iron segments slotted on the outer edge for carrying rivets or bolts. Two full sets of segments, one for handling 5/8-inch and 3/4-inch diameter material, and and the other 7/8-inch and 1-inch diameter, are supplied with the machine. Segments may, however, be used to accommodate any diameter of bolt or rivet. Material to be sorted of a single diameter, but of any length, is fed to the tray immediately above the machinei and inclined towards the operator, who places the pieces, as they move down a slide, into slots of the revolving table, which turns at about three revolutions per minute. This particular table speed has been determined as best for allowing the operators, working normally, to

Fig. 1.—Rivet and Bolt Sorting Machine

fill all the slots as they pass. As each rivet or bolt comes in contact with a cam set for its particular length, it is dropped through a chute to a keg containing bolts of that length. There are twenty cams arranged on the machine which may be adjusted to sort the bolts within 1/8-inch of any required length.

The relative costs of sorting by the hand-method and by machine indicate a saving per ton of about $6.34, according to the following schedules:

COST BY HAND

Two experienced men measuring bolts or rivets by hand can sort about twelve kegs in a 12-hour day.

Labor: Two men at 54 cents per hour...	$8.64
Normal Output: Twelve kegs, or 1 1/5 tons.	
Sorting Cost Per Ton:	$7.20

COST BY MACHINE

Two ordinary men working normally can feed rives or bolts to a sorting machine at the rate of 125 per minute, or 7,500 per hour. Assuming three pieces to the pound, this means 100 kegs per day.

Labor: Two men at 54 cents per hour...	$8.64
Sorting Cost Per Ton:	$0.86

MACHINE FOR ASSEMBLING NUTS AND BOLTS

Another machine of particular value in the salvage department is one de-

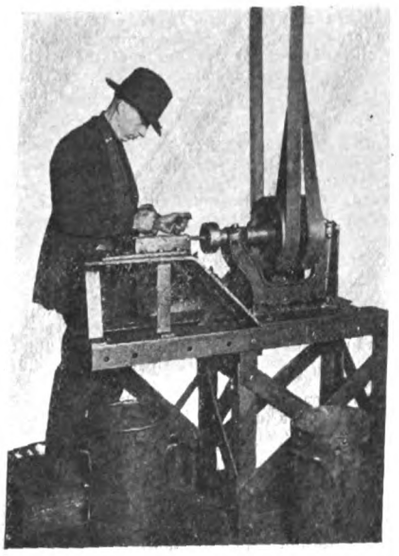

Fig. 2.—Bolt and Nut Assembling Machine

veloped for bolt and nut assembling. It it intended to replace the rather expensive bolt-threading and bolt-tapping machines ordinarily used. Bolts and nuts that have corroded form the great bulk of this type of material to be reclaimed in the shipyards. The machine is driven from a countershaft by open and crossed belts engaged by a foot-operated clutch on both the forward and reverse motions. The operation on the bolt is quite simple, consisting of clamping the bolt in a chuck, while a sliding chuck holding the nut runs it up over the threads.

For the purpose of comparing the costs of operation, the following data have been arranged from the performances of one bolt and nut assembling machine, and one triple-head, bolt-threading machine in conjunction with a six-spindle bolt-tapping device.

Production is on the basis of 3,000 pieces a day. The normal output for each method is as follows:

USUAL METHOD

Interest on investment, 6 percent.....	$1.00
Depreciation and maintenance, 15 percent	2.50
Insurance, 3/4 percent	.15
Labor threading, at 62 cents.....	4.96
Die replacement (1½ sets).....	9.00
Power, 10-horsepower 60 kilowatt hours, at 2 cents	1.20
Labor tapping, at 62 cents.....	4.96
Tap replacement (3)	5.25
Total per day	$29.02
Total per 1,000	9.67

BOLT AND NUT ASSEMBLING MACHINE

Interst on investment, 6 percent.....	.19
Depreciation and maintenance, 15 percent	.48
Insurance, 3/4 percent	.03
Labor starting nuts, at 46 cents.....	3.68
Labor operating machines, at 52 cents....	4.25
Power, 1½-horsepower 9 kilowatt hours, at 2 cents	.18
Total per day	$8.81
Total per 1,000	2.94

The Yale & Towne Manufacturing Company, of 9 East Fortieth street, New York City, announce the removal of their New York offices to Stamford, Conn.

The appointment of J. G. Miles to the position of supply division manager of the Westinghouse Electric and Manufacturing Company's Seattle office became effective January 1, 1920. Mr. Miles succeeds Mr. C. V. Aspinwall, now the company's representative at Spokane, Wash.

The Irving Iron Works Company, Long Island City, N. Y., has been awarded the contract for supplying all flooring-grating, walkways, and ladder steps for the two new super-dreadnaughts *California* and *Tennessee*. The product furnished will be standard Irving "Subway" grating and Irving "Safesteps," such as is already in use on over 500 vessels, including ships if the U. S. Army and Navy, the Emergency Fleet Corporation, and private concerns. The grating is to be galvanized throughout—a refinement in line with the exceptional requirements on these two new fighting vessels.

A statement of the results of a conference on the standardization of export quotations and American export practice, participated in by the nine great foreign trade organizations of the United States, and held under the auspices of the National Foreign Trade Council, has been issued by the council. Copies may be obtained by addressing O. K. Davis, secretary of the council, 1 Hanover Square, New York City.

The Black & Decker Manufacturing Company, of Baltimore, Md., will display their exhibit of electric air compressors, portable electric drills and electric valve grinders in Space E-88-89 at the coming Minneapolis Automobile Show. R. G. Ames, Chicago manager for the company, will be in charge.

Members of the engineering profession are invited to give thought to the opportunity to acquire foreign trade information offered by the Seventh National Foreign Trade Convention, which will be held in San Francisco, May 12-15, 1920. Announcement is made that at the coming Convention special trade advisors will be present from the Far East, Australasia and South America, to be consulted by American business men. In conjunction with the Convention there will be special foreign trade exhibits, held under the auspices of the Los Angeles and Seattle Chambers of Commerce in these two Coast cities.

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Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIP CONTRACTS

Schooners, Victoria, B. C.—Six 2,000-ton five-masted topsail schooners are planned to be built by a new company, headed by Mr. Harry Barnett.

Repairs to Steamers, Baltimore, Md.—Baltimore Dry Dock & Shipbuilding Company has received two new repair contracts—the steamers Saris and Angelina.

Lighthouse Tenders, Morris Heights, N. Y.—The Consolidated Shipbuilding Corporation has been awarded contracts by the Department of Commerce for the construction of two lighthouse tenders at a cost of $714,000.

Converting Barge, Noank, Conn.—The Groton Iron Works are converting the excursion barge Empire into a cargo carrier. She is owned by the Thames Specialties Company of Montville.

Skinner & Eddy Corporation, Seattle, Wash.—It is understood that the Skinner & Eddy Company has several large private contracts pending, on which work will begin early in the year.

Harbor Tugs, Eastport, Md.—Three 100-foot harbor tugs are under construction for the Shipping Board at the Chance Marine Construction Company's yard, at Eastport, near Annapolis, Md.

Dredge Hull, Portland, Ore.—The United States Engineers' Office has let contract for building one wooden dredge hull, with house, First District, to Skandia Shipbuilding Company, Marshfield, Ore. Cost $12,883.

Freight Steamers, Baltimore, Md.—The Baltimore Dry Docks & Shipbuilding Company will build two freight steamers on own acount. They will be 353 feet long, 49 feet beam and 28 feet 7 inches in depth.

The Lake Union Dry Dock & Machine Works, Lake Union, Wash., has sixteen cannery tenders and fishing vessels assembled at its new plant with a large number of smaller craft to be repaired and overhauled.

Sailing Vessels, Eureka, Calif.—The Rolph Shipbuilding Company will lay the keel for a five-masted barkentine with a lumber capacity of 2,000,000 feet, and which will be the largest sailing vessel ever launched on the Pacific coast.

A Submarine Tender and Repair Ship at Bremerton, Wash., at an estimated cost of $6,250,000, have been authorized for construction at the Puget Sound Navy Yard. The vessels will be built in the large dry dock recently dedicated.

Repairing Steamer, Staten Island, N. Y.—The National Dry Dock & Repair Company has been awarded the contract to repair the steamer Neuse, at a cost of $89,000. The work will require fifty-six days and the boilers will have to be rebuilt.

Oil Tankers, San Francisco, Calif.—The Schaw-Batcher Shipyards, South San Francisco, have received a contract from the Union Oil Company for the construction of two 12,000-ton tankers which it is estimated will carry about 87,000 barrels of oil.

Repairing Steamer, Tacoma, Wash.—The Todd Dry Dock & Construction Corporation, Inc., Tacoma, has been awarded a contract by the Shipping Board for repairing and overhauling the steamship Eastern Guide, to cost approximately $100,000. The ship is to be converted from a coal to an oil burner.

Liners for Peninsular & Oriental Steam Navigation Company.—It is reported that an order has been placed with Harland & Wolff, Belfast, for five liners of the B class for the Australian emigrant and cargo service, via the Cape. The ships will be about 13,800 tons each.

Freighter and Tanker, Freeport, Tex.—The Freeport Sulphur Company is having two new 6,000-ton vessels built in a New Jersey shipyard. One of these vessels is a tanker, the other is a freighter which is being built especially for the transportation of sulphur. Both vessels wil draw 22 feet of water.

Fourteen Isherwood Type Ships, Three Rivers, Que.—The National Shipbuilding Company has been awarded contracts by French interests for building six 7,200-ton boats on a basis of $120 per ton, six 4,200-tonners at $180 per ton, one 3,250-tonner at $185 per ton, and one 6,500-ton oil tanker at $185 per ton.

Ocean Vessels, Great Lakes.—The American Shipbuilding Company, Cleveland, Ohio, is obtaining material for several vessels to be delivered at tidewater in 1920. The McDougall-Duluth Shipbuilding Company, Duluth, Minn., and the Manitowoc Shipbuilding Company, Manitowoc, Wis., are to build four steamers for ocean trade.

Refitting Steamers, Chelsea, Mass.—The Richard T. Green Company has finished extensive repairs and refitting contracts on the steamers Hahoning, Waxahachie, Lake Medford, Alvada, Lake Faulk, Lake Fonda, Lake Ellenorah, Lake Fannin, and Lake Fithian for the United States Shipping Board.

Merchant Fleet, Argentine, S. A.—The Argentine Government is planning to create a merchant marine of about 400,000 tons, in order to be independent of foreign shipping. This merchant fleet, consisting of vessels of large tonnage, will be built in Spanish shipyards, with part of the proceeds of the $100,000,000 loan now being negotiated by the Argentine Government with the Bank of Spain.

Reconditioning Steamer, Belfast, Ire.—The United Fruit Company's steamer Sixaola (5,000 tons), has been placed in the hands of Workman, Clark & Company for reconditioning on release from four years' Government service. The Sixaola is the fifth vessel of the "White Fleet" now in the port for a similar purpose, while several others are on the stocks. The Sixaola will be converted into an oil burner.

Steel Cargo Vessels, Finland.—Maskin-och-Brobyggnads Aktiebolaget has launched the Finlandia, owned by the Atlantic Rederiaktiebolaget. This is the first of a number of vessels contracted for, and represents the successful culmination of an attempt to build steel cargo vessels in Finland. The Finlandia has 1,500 deadweight tons capacity, built at a cost of 3,000 Finnish marks per ton. (The present average exchange value of the Finnish mark is 5.75 cents.)

Tanker, Tampa, Fla.—The Oscar Daniels Company received a contract from the Standard Oil Company of New Jersey for constructing a tank oil carrier of 11,000 tons. The vessel will be 481 feet long over all, 465 feet between perpendiculars, 60 feet beam, and 36 feet 3 inches deep from shelter deck. The engines will be oil-burning quadruple expansion, of 2,800 horsepower, with three Scotch boilers, and will give a speed of ten and a half knots. The contract calls for completion this year.

Steamships, Cunard and Allied Lines, Glasgow.—The Cunard and allied interests have thirty-four ships under construction at the yards of the Fairfield Shipbuilding & Engineering Company and Alex. Stephens & Company in Glasgow, and the Vickers Yard at Barrow-in-Furness. They are all of the intermediate, or pasenger and cargo carrying type. Contracts have also been placed for more than 100,000 additional tons, the keels of which have not yet been laid. The aggregate tonnage when the program is completed will be more than 500,000 deadweight tons.

Auxiliary Knockabout Schooner, East Boothbay, Me.—Hodgdon Brothers received a contract from Donald B. McMillan, the Arctic explorer, to build an auxiliary knockabout schooner of 55 gross tons. The craft will be named Bowdoin, for Bowdoin College. Her principal dimensions will be 85 feet long over all, 22 feet beam and 9 feet, 7 inches draft. A 45-horsepower Fairbanks-Morse kerosene oil engine will furnish auxiliary power. The cruising radius will be 3,000 miles and tank capacity 2,000 gallons. The Bowdoin is designed especially for Arctic exploration.

Tankers for Sinclair Navigation Company.—Contracts have just been placed by the Sinclair Navigation Company, 120 Broadway, this city, for eight bulk oil carriers, aggregating more than 77,000 dead weight tons. Four of the ships, two of 10,600 tons each and two of 6,900 tons each, are to be built by the Harlam plant of the Bethlehem Shipbuilding Corporation, Ltd., at Wilmington, Del.; two of 10,600 tons each by the same corporation's plant at Fore River, Quincy, Mass., and two of 10,600 tons each by the Sun Shipbuilding Company at its Chester, Penn., plant.

NEW SHIPYARDS AND SHIPYARD EXTENSIONS

Canada to Aid Shipyards.—The Canadian Government has decided to make loans to all Pacific coast yards needing assistance, up to 75 percent of the cost per ship, according to advices received at Seattle.

Floating Dry Dock, Vancouver, Wash.—The Port Commission and other interests of the city are considering the building of a floating drydock of six wooden pontoons, with steel wings, for ships of 12,500 tons capacity.

New Shipyard, Halifax, N. S.—C. N. Delaite of the Winnisimnet Shipyards, Chelsea, Mass., was recently in Halifax looking over its possibilities as a site for a branch yard. The plant, if built, will construct wooden ships of all classes.

Lining Dry Docks, Paris Island, S. C.—Spec. 3979. Until February 4 bids will be

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received by the Bureau of Yards and Docks, Navy Department, Washington, D. C., for lining dry dock with concrete. $10 deposits required for plans and specifications.

Boat Building Yard, Karachi, India.—B. R. Herman & Company are about to erect a plant for the building of boats, motor boats, launches, etc. The new plant will be on a water frontage, and will have all equipment necessary to the economical and expeditious conduct of industry.

Floating Docks, Argentina, S. A.—A proposed series of floating drydocks to cost not less than $20,000,000 has been suggested to the Congress of Argentina. Plans call for the construction of 18 of these structures, to be located in the Parana, Uruguay and Paraguay rivers.

Groton Iron Works, Noank, Conn.—P. LeRoy Harwood, receiver of the Groton Iron Works, denies rumors that the yard is to be discontinued. "The yard will remain a permanent industry," said Mr. Harwood, "and the year 1920 will not see the dissolution of the plant."

Shipyards Sold, Portland, Ore.—Messrs. Barde & Son have bought the Sommarstrom Shipbuilding Corporation's yard equipment and have started wrecking operations. The company also took over the Foundation Company's equipment, and that of the Albina Engine & Machine Works.

Dry Dock, Portland, Ore.—The city is having plans prepared by G. B. Hegart, chief engineer Public Dock Commission, for a 15,000-ton drydock, consisting of five pontoons, 3,000 tons capacity each, similar to the large docks of the Skinner & Eddy Shipbuilding Company, to cost about $800,000.

Repairing Dry Dock, Brooklyn, N. Y.—Spec. 4014—Bids will be received until February 11, by the Bureau of Yards and Docks, Navy Department, Washington, D. C., for repairing drydock No. 4, in the Navy Yard, Brooklyn. About $100,000; $10 deposit required for plans and specifications.

Shipyard Control Changed, Wilmington, Del.—The yacht and boat building business of Beebe & Baxter has been taken over by William H. Beebe and Captain Malcolm Billsborough, who plan a number of improvements. The firm is at present engaged in finishing the yacht Pythagoras, for E. Paul du Pont.

Wood Cutting Shop, Lake Union, Wash.—The Lake Union Dry Dock & Machine Works is about to begin construction of large wood cutting shop, the machinery and lumber for which has already been assembled. In conjunction with the Lake Union concern, Estep & Kimball will establish a $75,000 machine shop in one of the plant buildings.

Dry Dock, Quincy, Mass.—Preliminary work on the big dry dock to be built for the Bethlehem Shipbuilding Corporation has begun. In connection with this a contract for $500,000 was recently let to M. M. Davis & Son, Inc., for the construction of ten pontoons, each to be 116 feet long, 41 feet wide, and 13½ feet deep. The dry dock will accommodate ships of 10,000 tons.

Shipyard Leased, Houghton, Wash.—Preparatory to entering the ship repair business on a large scale and to complete two wooden ships now on the ways, the J. H. Price Construction Company has taken over the Adverson Shipbuilding Corporation's plant at Houghton, Lake Washington, under a five-year lease. Six small vessels are at the plant for repairs, and others are ready for overhauling.

The Lord Dry Dock Company, a subsidiary of the Lord Construction Company of Providence, R. I., has taken over the plant of the Weehawken Dry Docks Company and purchased 2,000 front feet of land on the west shore of the Hudson river and will carry on extensive ship repair work. Six piers, 1,000 by 60 feet, are called for by present plans. Each pier will carry two tracks on a concrete dock. Shops will be of concrete and steel, the buildings 250 by 125 feet, and two 10,000-ton floating docks, one to become part of the equipment as soon as possible, are to be built.

New Shipbuilding & Dry Dock Company, Baltimore, Md.—The Globe Shipbuilding & Dry Dock of Maryland, an extension of a company of the same name located at Superior, Wis., of which Benjamin C. Cooke is president, has purchased a thirty-acre tract with 1,000 feet water frontage in the Curtis Bay section of Baltimore, will move the Superior plant to Baltimore bodily, and create a large shipbuilding and repair plant. The project is backed by Baltimore business men and bankers, and the work is to be completed within the next ninety days.

Dry Dock, Pensacola, Fla.—The Bruce Dry Dock Company has launched the second section of its 6,000-ton drydock. The third and fourth sections are well under way, and it is expected that the dock will be ready for commissioning by April 1. The second section was 65 feet in length, 94 feet in width, and had a pontoon twelve feet deep. There will be five sections in all. The company has awarded contracts for three fireproof buildings to be used in connection with the dock's operation. One of these will be 100 by 80 feet, one 86 by 40 feet, and the third 100 by 160 feet.

HARBOR IMPROVEMENTS

Jetties, Humboldt Bay, Wash.—The United States Engineers Office, War Department, Washington, has rejected bids for furnishing stone for jetties.

Dredging, Savannah, Ga.—The U. S Engineer office has let contracts for dredging in Savannah Harbor to J. Emile, Duval Building, Jacksonville, Fla. About $94,500.

Dredging, Nantucket Sound.—The United States Engineers Department announces the establishment of special buoys in Nantucket Sound to facilitate dredging operations.

Dry Dock, Astoria, Ore.—The Port of Astoria Commission is having plans prepared for a drydock, to cost about $1,000,000. R. R. Bartlett, Astoria, engineer in charge.

Dredging Canal, Beaumont, Texas.—The Lake Arthur Dredging Company made the lowest bid of $135,000 for dredging a canal between Mermentau and Calcasieu Rivers.

Quarantine Station, Providence, R. I.—Strenuous and persistent efforts are being made to secure the construction of an adequate quarantine station, to cost about $600,000.

Repairing Coal Wharf, San Diego, Calif.—Spec. 4117.—The Bureau of Yards and Docks, Navy Department, Washington, plans to repair coaling wharf here. About $4,000.

Harbor Improvements, Antofagasta, Chile.—The Chilean Government has contracted for harbor improvements to be made at Antofagasta, costing approximately $8,500,000.

Extend Harbor Area, San Francisco, Calif.—City plans to extend harbor area by removing Rincon Hill, involving 3,000,000 cubic yards earth excavation. Cost will be about $3,500,000.

Dock, Portland, Ore.—The Crown Mills has let contract for building a dock 100 by 106 feet, on Front street between Ninth and Tenth streets, to A. Kaufman, Gasco building. Cost about $30,000.

Dredging, Seattle, Wash.—U. S. Engineer Office, War Department, Washington, D. C., plans to dredge the channel at entrance to Port Gamble Harbor, 2,500 feet long, 28 feet deep and 150 feet wide. About $24,000.

Municipal Wharf, Etc., Orange, Tex.—The $150,000 issue of wharf and dock bonds has been disposed of, and work can now be pushed on the municipal wharf and dock improvements to be made wtih the money.

Buoys, Yorktown, Va.—Spec. 4068.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., has let contract for furnishing four mooring buoys here to S. J. Smith, Gloucester Point, $6,576. (120 days.)

Dredging, Stamford, Conn.—Proposals for dredging in Stamford Harbor, Conn., will be received at the U. S. Engineer Office, Providence, R. I., until 2 o'clock P. M., February 9, 1920. Further information on application.

Floating Terminal, St. Louis, Mo.—The United States Railroad Administration has let the contract for building a floating terminal 280 feet long and 75 feet wide to the Dubuque Iron Works, Dubuque, Ia. Cost $280,000.

Pier, Portland, Me.—The Maine State Pier Commission, offices in Augusta, Me., plans to build a concrete and steel pier at Portland to cost about $2,000,000. Fay, Spofford & Thorndike, 15 Beacon street, Boston, are the engineers.

Dredging, Wilmington, Del.—U. S. Engineer Office, Old Federal Building, has let contract for dredging in Cooper River to American Dredging Company, Mariners & Merchants' Building, Philadelphia, Penn. About $9,500.

Quay Wall, Norfolk, Va.—Bureau of Yards and Docks, Navy Department, Washington has let the contract for building a quay wall at Norfolk, to H. P. Converse, Thirty-first street and Colonial avenue. About $250,634; time limit 300 days.

New Harbor, Nairn, Scotland.—The Town Council of Nairn is planning to extend and improve the harbor there, with a drift shelter to accommodate about fifty steam or motor fishing vessels. The total cost is estimated from £95,000 to £100,000.

Dredging, Delaware River.—Bids will be received by the United States Engineers Office, 815 Witherspoon building, Philadelphia, until February 18, for dredging Delaware River, Philadelphia Harbor. Information at above address.

Pier, Curtis Bay, Md.—Standard Guano Works, 1214 Continental Building, Baltimore, have let contract for building 40x200 ft. wood pile and timber pier at plant there, to Whiting-Turner Company, Stewart Building, Baltimore, Md. About $50,000.

Dredging, Astoria, Ore.—The Port of Astoria Commission has preliminary plans for dredging Youngs Bay, Port Dock to Wilsons, cost $15,000. Port Docks piers 4, 5, 6, $200,000; Wilsons to Wallusky, $385,000. R. R. Bartlett, Astoria, is engineer.

Harbor Improvements, San Francisco, Calif.—The Board of Harbor Commissioners has completed plans for the construction of $2,000,000 worth of harbor improvements which wil greatly increase the present wharf facilities and relieve the seasonal freight congestion.

Coal Dock and Loading Pockets, Grand Rapids, Mich.—Kent Fuel Company, 1230 Taylor avenue, have let contract for building reinforced concrete coal dock and loading pockets, including conveyor and electrically operated loading machine, to A. W. Morgan, Grand Rapids.

Shipping Terminal, Seattle, Wash.—The new public shipping terminal now in process of construction at Smith Cove, at a cost of $2,500,000, will be ready to berth ships and handle cargo by May 1, according to George F. Nicholson, chief engineer of the Seattle Port Commission.

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Dredging, Mystic River, Conn.—The State Department of Public Works through the Department of Waterways and Public Lands has undertaken the dredging of the entrance to the Mystic River. The plan calls for a depth of 30 feet at mean low water near the mouth of Island End River.

Shed and Piers, New York.—Department of Docks Pier "A" North River, has let a contract for building a shed at Eighteenth Street Pier, East River, and reconstructing pier at foot of Twenty-fifth street, East River, to the Associated Contractors, Inc., 17 West Forty-second street, New York.

Industrial Plants, Baltimore, Md.—The Union Acid Works will build a $1,000,000 plant and will dredge a 25-foot channel and build a modern pier with a 2,000-ton capacity. The Kennedy Corporation will build a $2,000,000 plant for the manufacture of automobile parts, with shipping connections.

Wharf and Warehouses, Charleston, S. C.—The wharf and warehouses of the Accommodation Wharf & Warehouse Company were sold to Henry F. Barkerding, Charles R. Allen, Hyman Pearlstine and E. F. A. Wieters for $200,000, who intend to make extensive improvements on the property.

Equipment of Docks, Leith, Scotland.—The Dock Commissioners of Leith have decided to spend £52,000 for the purpose of further equipping docks with capstans to be placed at suitable points so as to permit hauling of wagons along quay fronts, where locomotive haulage is unsuitable and uneconomical.

Improvements on River Front, Sacramento, Calif.—John Q. Brown, Commissioner of Public Works, announces that immediate action will be taken to better conditions on the waterfront, and has instructed City Engineer Frank C. Miler to make a survey in order to determine an estimate on the probable cost of contemplated improvements.

Pier, Fore River, Mass.—It is expected that in the early spring a new wharf, warehouses and apparatus for loading and unloading ships and railroad cars will be erected on the 310,000 feet of land recently purchased by John W. Gulliver, of Portland, acting for Philadelphia interests. This involves an expenditure of about $550,000.

Widening Channel, Willapa Harbor, Wash.—The United States Dredging Company was the only bidder for the widening of the main channel of Willapa harbor to a width of 200 feet. The bids were asked for by the United States Engineers Department. The bid submitted calls for $14.95 per cubic yard for removal of rock from the channel, and $0.1795 for dirt.

Pier, Colon, Panama.—The deck construction department of the Panama Canal is building a pier on the foundations of the old pier of the Royal Mail Steamship Company. The new pier is 490 feet long, 62 feet wide. The floor is of reinforced concrete, the roof supported by 20 trusses, and both it and the side walls will be of corrugated iron. A track of the Panama Railroad wil run to the pier.

Wharf, Etc., Everett, Wash.—The Port Commission proposes to buy 1,700 acres of tide flats for development as future wharf and industrial sites. These flats lie to the left of the Snohomish River, where it enters the Sound at the north end of the peninsula on which Everett stands. Construction of retaining walls, and extensive dredging and filling, will be necessary to make the tract available for use.

Sea Wall, Etc., Toronto, Ont.—The city plans to build a precast mass concrete sea wall on wood piles from Humber River to Eastern Gap, a brick and steel warehouse at the foot of York street, large bathhouse, wood construction, amusement park at Sunnyside, improve beach at Scarboro, and complete Sunnyside boluevard. About $4,000,000. E. L. Cousins, Harbor Building, engineer.

Reconstruction, Delaware and Chesapeake Canal.—It is announced that the Federal Government plans to spend $2,000,000 on improvements and reconstruction work on the Delaware and Chesapeake Canal before June, 1921. The work includes purchase of land, construction of new bridges, dredging and other contract work. Information can be obtained from Col. John P. Jervey, U. S. Engineers Office, Wilmington, Del.

Harbor Improvement, Warrenton, Ore.—The Port of Warrenton has empowered a dock commission and authorized the issuing of $350,000 in municipal bonds to carry on work of improving its waterfront. A second measure authorizing $150,000 in bonds for the purchase of two tracts of water frontage of fifty acres each, on the Skipanon and Columbia Rivers, to be fitted up for warehouses, dockage and industrial purposes, has also been adopted.

Tanks, Seattle, Wash.—The Seattle Boiler Works has won the contract on its bid of $13,980, from the Port of Seattle Commission, for the construction of two 250,000-gallon steel oil tanks at the Pier A terminals at Smith Cove. The tanks are already leased, as are two other 50,000 gallon tanks now being completed by an Oriental oil company entering the field, the identity of which has not yet been announced. The tanks will be completed in sixty days.

Dredging Channel, Duluth, Minn.—Plans for dredging the channel of sufficient depth to enable the largest Great Lakes freighters to approach the new receiving dock of the Zenith Furnace Company of Duluth are completed. The improvement, which will involve an expenditure of about $10,000,000, calls for deepening the St. Louis River a distance of nearly a mile through Spirit Lake. The dock will be large enough to handle four boats at one time with modern unloading bridges and equipment.

Dredging and Slips, Tacoma, Wash.—The Port Commission of Tacoma has decided to ask for bids for the dredging of channels and slips in the tide flats recently purchased. The water frontage is 3,000 feet and the depth 4,500 feet. The site will provide a berthing place for fifty 500-foot steamers. The present waterway will be dredged to 35 feet depth. An open pier 1,200 feet long and 226 feet wide, and a transit shed 1,000 feet long and 180 feet wide with full equipment, will be the first unit constructed.

Port Improvements, Milwaukee, Wis.—Lieut. Col. Edward H. Schulz, engineer of the Milwaukee port district, has announced plans for improvements. It is proposed to repair east revetment at Grassy Island, Green Bay, Wis., continue repairs to revetments at Sturgeon Bay Canal, Wis., and Waukegan, Ill., and to repair piers and revetments at Grand Haven, Frankfort and Charlevoix, Mich. It is further proposed to complete concrete superstructure on south pile pier at Manistee, and construct caissons at Milwaukee for breakwater at Indiana Harbor, and to do necessary dredging for maintenance of harbors in the district.

Improvements at Navy Yard, Bremerton.—Among the improvements planned at the Puget Sound Navy Yard, Washington, to be proceeded with at once, are two drydocks, each 1,000 feet long, to cost $9,000,000; a fitting out pier 100 by 1,200 feet, $1,500,000; extension piers 4 and 5, 700 by 80 feet, $896,000; one merchandise pier, 125 by 1,200 feet, $1,200,000; 22,200 feet approach and ladder car storage track, $133,200; S. C. S. storehouse, 260 by 500 feet, $3,120,000; a total expenditure of $15,849,200. Other water front improvements to be considered later, aggregating $9,370,000 in cost include two 475-foot drydocks at $750,000 each; two 2,000-ton marine railways at $250,000 each; two merchandise piers, 30 by 1,200 feet, $3,850,000; 350 gross ton fitting-out crane, $1,000,000; and two auxiliary fitting-out cranes 5-10-ton, $120,000.

SHIPPING DEVELOPMENTS

Steamship Line, Georgetown, S. C.—Georgetown & Conway Steamboat Line, Inc., capital $15,000 has been organized by Joseph Schenk, E. W. Kaminski and F. D. Rosa.

Freight Line, Portland, Ore.—A monthly freight service between Portland and the Hawaiian Islands has been inaugurated by Parrott & Company, who have offices in San Francisco and a branch office in Portland.

Steamship, Holland.—The Holland America Line has begun the building of a new Staatendam to replace in its passenger service a vessel of the same name, sunk during the war. The vessel will be of 30,000 tons.

Portland, Me.-Mediterranean Service.—Announcement has been made that the White Star-Dominion Line is to establish a freight service from Portland to Mediterranean ports, the first sailing to be early in February.

Direct Line from Halifax, N. S., to Brazil.—The Marine Navigation Company of Canada will operate a direct line of steamers between St. John, N. S., and Halifax, N. S., and Brazilian ports, with five 5,000-ton vessels now under construction.

Steamships to be Returned, New York.—Tht Southern Pacific. Old Dominion and Ocean Steamship lines will be returned to their owners on March 1, after being under control of the United States Railroad Administration for twenty-six months.

Navigation Company, Peru, S. A.—The Chungwa Navigation Company, Ltd., has been inaugurated by Peruvian and Chilean merchants to provide a freight service between the west coast of South America and China, to stimulate the nitrate trade.

New Steamship Line, Boston.—The Patterson-Wylde Line will operate a line from Boston to Manchester, England. A steamer has been allocated to the company by the Shipping Board and others to maintain the service have been assured. The first sailing is to be about February 10.

Inter-Island Steamship Line, West Indies.—Cuban capital will organize an inter-island line to operate seven or eight steamers between ports for passenger and cargo service, according to J. A. Marques, Jr., steamship broker of Havana. Rafael Doniphan, Ha ana, is director of the new line.

Tanker Company, Dover, Del.—The Union Oil Steamship Company has been incorporated with capital stock of $50,000,000. The incorporators are M. L. Rogers, L. A. Erwin and W. G. Singer of Wilmington. The corporation is a subsidiary of the Union Oil Company and will take over the navigation work of that company.

Freight Service, New York.—The Dollar Steamship Company, which recently purchased a large tract of water front in the Hunt's Point section of the Bronx, is establishing an office at 44 Whitehall street, New York, and will operate a freight service from this port to ports of the Orient, beginning within hte next six weeks.

New Steamship Company, Brownsville, Tex.—The Rio Grande Gulf Steamship Company, recently organized, with D. A. O'Brien as president, will establish a line of passenger and freight steamships between Point Isabel and Tampico, Mexico, about February 15. The first ships for the proposed line were recently purchased in New York.

Steamship Line, Boston, Mass.—Rogers & Webb, of State street, will operate a line to Avonmouth and Hull, England, a 5,400-ton steamer having been allocated to the concern by the Shipping Board, with assurance of other steamships of equal tonnage in the near future. The first fortnightly sailing will be about the midle of February.

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